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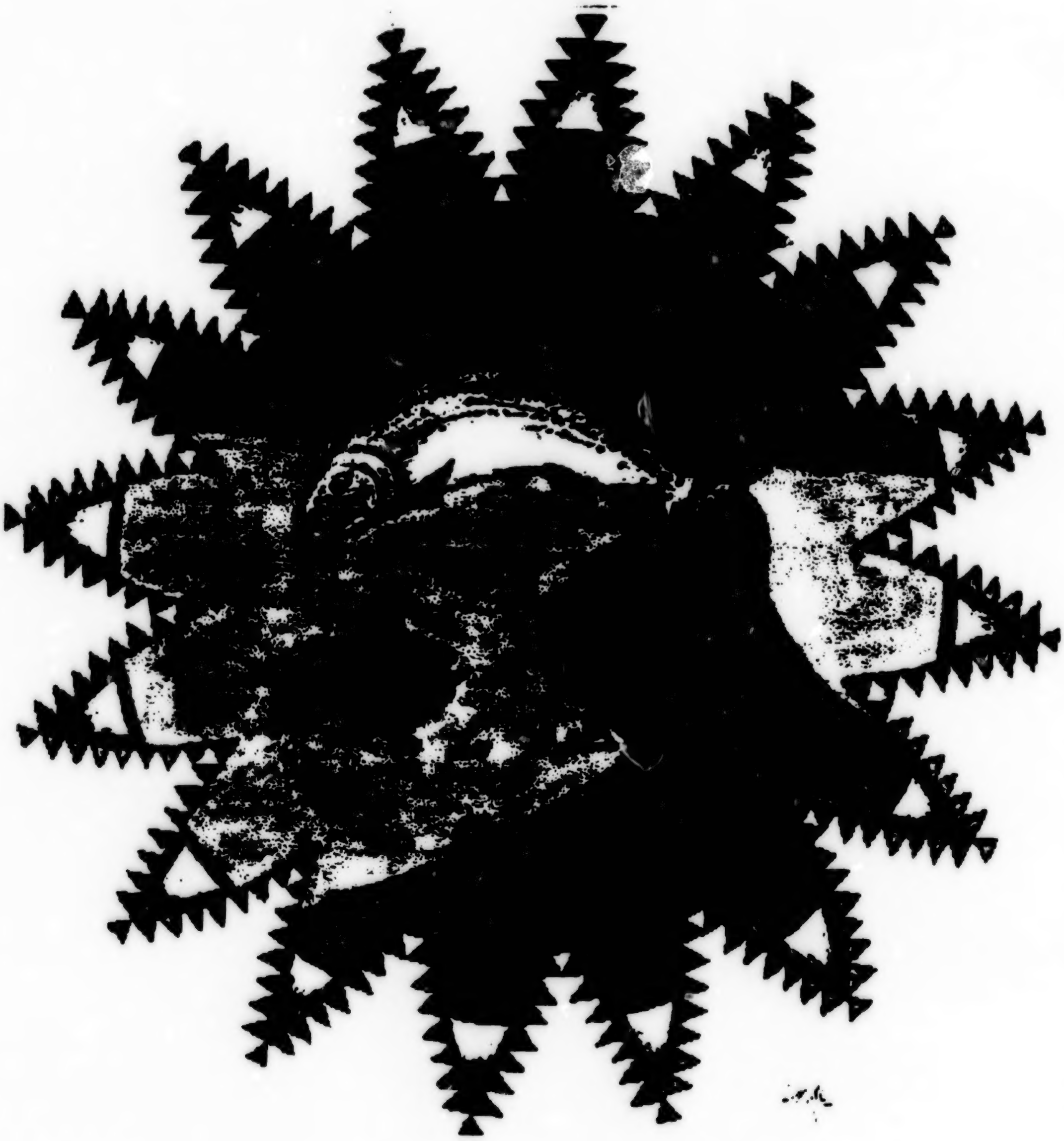
Hoopa Valley Tribe

Pine Creek Sediment Monitoring Project
Contract No. 14-48-0001-92507



15 September 1997

2002-011613/NF

Abstract

Pine Creek is a tributary to the lower Klamath River. The 49 sq. mile watershed has been heavily logged. Bulk sediment samples were collected with a McNeil sampler over a three-year period at 7 stations in Pine Creek and at one in Little Pine Creek . The samples show no change with location and no change over time.

Introduction

The Hoopa Tribal Fisheries Department developed and implemented a watershed restoration project in the Pine Creek watershed. Pine Creek is a tributary of the lower Klamath River. Pine Creek has been identified as having high potential to produce anadromous Chinook salmon and steelhead trout. Pine Creek was chosen as a model watershed to implement and monitor the effectiveness of watershed restoration techniques. A Cooperative Agreement between the US Fish & Wildlife Service and the Hoopa Valley Tribe was used to fund this demonstration project.

Description of the Study Area

The Pine Creek watershed has an area of 49 square miles (Figure 1). The watershed is in part located on the Hoopa Reservation (approximately 21 square miles), in part on the Yurok Reservation, with the remainder in fragmented federal, industrial, and private landholdings. The headwaters of the watershed have elevations in excess of 3,000 feet and the confluence with the Klamath River has an elevation of approximately 300 feet. Pacific Watershed Associates completed a detailed assessment of the Pine Creek watershed for Hoopa Valley Fisheries Dept. in 1990. That work should be consulted for more detailed information. The entire watershed has been heavily logged and has more than 100 miles of logging roads.

Methods and materials

Study design was the standard approach developed by Pacific Watershed Associates (PWA). Eight study sites were identified at the end of the 1991/1992 winter. These sites are shown in Figure 2.

Local survey control monuments (1/2" rebar) were placed at each site in 1992. Longitudinal channel profiles and cross-sections were surveyed using techniques advocated by PWA. Hoopa Valley Fisheries Dept. technical staff were trained in the use of these techniques by PWA principals.

After longitudinal profiles and cross-sections were surveyed, scour chains and crest-stage gauges were installed at selected locations. The scour chains and crest-stage gauges were intended to assess the depth of streambed scour and associated flood stages at selected locations during the study period. These installations were made during the fall of 1992.

At the same time that scour chains and crest-stage gauges were installed, bulk sediment samples were collected using a modified McNeil sampler. Bulk sediment samples were taken at eight sites in 1992, 1993, and 1994. Sample site selection methods were standard for the techniques developed by PWA.

All samples were sieved through a series of screens with mesh sizes as follows:

124 mm
90 mm
63.5 mm
31.5 mm
12 mm
4 mm
1 mm
0.5 mm
0.125 mm

Samples passing through the 0.125 mm screen were settled out in Imhoff cones. All samples were measured volumetrically, using PWA modifications of the method described by McNeil (1963).

There was some variability in bulk sample processing. Some samples from the more inaccessible sites were processed in the field. This process was somewhat weather dependent. Samples from the more accessible sites were processed at the Hoopa Valley Fisheries Dept. facility in Hoopa.

Results and discussions

Pine Creek is a very high energy stream with steep gradients and a very flashy hydrograph. Local flood peaks rise to relatively remarkable heights following intense rainstorms or rain-on-snow events. Prolonged drought conditions preceding the study period led site design and layout personnel to make errors in selecting the locations of site survey control monuments. Most of these were lost in the 1992-1993 storm season, along with most of the crest-stage gauges and scour chains. The flood peaks associated with the 1996-1997 winter storms completely removed staff gauges and sediment sampling stations installed by personnel who had worked on the 1992-1995 study in what were believed to be secure locations . No scour chain or crest-stage data are available for the study period.

Longitudinal Profiles

Longitudinal profile data are presented by Site in Appendix 1.

Cross-sections

Cross-section data are presented by Site in Appendix 1.

Bulk sediment samples

Quantitative details of the bulk sediment samples are presented in Appendix 2.

There is a general consensus among hydrologists that streams are at their most efficient a[illegible]rming work (i.e., moving sediment) at bankfull discharges. The quantitative streamflow regime associated [illegible]h bankfull discharge can usually be calculated from on-site evidence and does not require contemporary discharge measurements.

High-flow or bankfull discharge marks at several cross-sections were used to estimate bankfull discharge and therefore water velocities associated with bankfull events. Average maximum velocities in the Pine Creek channel sites will range between 2.25 ft/sec (@ 70 cm/sec) and 6.25 ft/sec (190 cm/sec). The classic Hjulstrom diagram was used to predict the percentage of bulk sediment sample material that is likely to be moved during a bankfull event.

The Hjulstrom diagram predicts that a 70 cm/sec velocity will move a particle less than or equal to 5.4 mm diameter and a 190 cm/sec velocity will move a particle less than or equal to 16 mm diameter. Minimum and maximum percentages of mobile substrate moved during a bankfull event are shown by site and sample in the table below:

Site	Sample	Min %	Max %
1	1992a	46	70
1	1992b	41	66
1	1993c	19	48
2	1992a	44	69
2	1993b	41	66
2	1994c	40	65
3	1992a	40	63
3	1993c	37	60
3	1994d	43	71
12	1992a	41	72
12	1993b	39	64
19	1992a	46	72
19	1993b	35	59
20	1992a	50	70
20	1993b	37	62
21	1992a	45	66
21	1993b	41	66
Lpine	1992a	41	66

These data indicate that the substrate sampled from 7 sites in the main Pine Creek channel and from one site in Little Pine Creek are quite uniform. They do not indicate that there has been any change in the character of the substrate either by location or over time.

Summary and conclusions

Inspection of existing geological maps, USGS topographic maps, and existing stereo aerial photographs of the Pine Creek watershed indicate the high probability of one or more geologic contacts and fault controlled drainage patterns in the watershed. Coast Range watersheds with this type of geomorphology normally receive a large portion of their annual sediment loads from mass movements. Streams with fault controlled drainage patterns frequently have a large portion of their substrate made up of finer material. In an undisturbed state, such watersheds exhibit quite variable but frequently high sediment loads, with a relatively large portion of those sediment loads made up of the smaller size classes.

These Coast Range watersheds have historically produced variable sized runs of anadromous fish, often large but sometimes even extirpated as a result of tectonically- and fluvially controlled sedimentation. Sediment delivery rates have increased following decades of virtually uncontrolled road building and logging. There is no dispute that Pine Creek's channels are filled with sediment. This high energy stream may once have been in a supply-dependent mode but it is now in an energy-dependent mode and can be expected to remain in that state for some time to come. The results of this study quantitatively demonstrate this statement.

Qualitatively, any efforts which decrease the amount of sediment that can enter Pine Creek at any time in the future are desirable. Given the "erosional hangover" quantified by PWA's analysis (in excess of 120,000 CY or 160,000 tons), a major erosion control effort is clearly justified. But to expect to be able to demonstrate a direct cause-and-effect reduction in sediment in Pine Creek as the result of completing two erosion control projects is unrealistic. Only 10 to 15 percent of the accessible erosional overload was stabilized. This amount, although considerable, may not even be within the margin of error associated with the PWA inventory. Inaccessible quantities were not treated. The amount of entrained sediment, certainly large, was not addressed.

If nothing else, this study justifies the expense of sediment-budget based programs and demonstrates the cost-effectiveness of erosion control programs based on avoidance design, strict enforcement of contract provisions, and the adoption of "Best Management Practices".

These statements are not intended to say that this study was a waste of time or money. The highly mobile nature of the non-bedrock substrate in Pine Creek has been quantitatively described. Revisiting adequately monumented sites after high-flow years or on a periodic basis is recommended. This study provides some base-line data that would otherwise not have been collected. The real benefits of this study lie in its potential to influence Hoopa's resource management activities in the future.

Summary of expenditures

See following sheet

Section G. Summary of expenditures, including a list of major property purchased during the project.

CATEGORY	1992	1993	1994	1995	1996
Personnel and Fringe	1,564	18,042	8,373	5,250	968
Supplies[1]	0	1,704	236	0	0
Travel	0	200	0	0	0
Total	1,564	19,946	8,609	5,250	968

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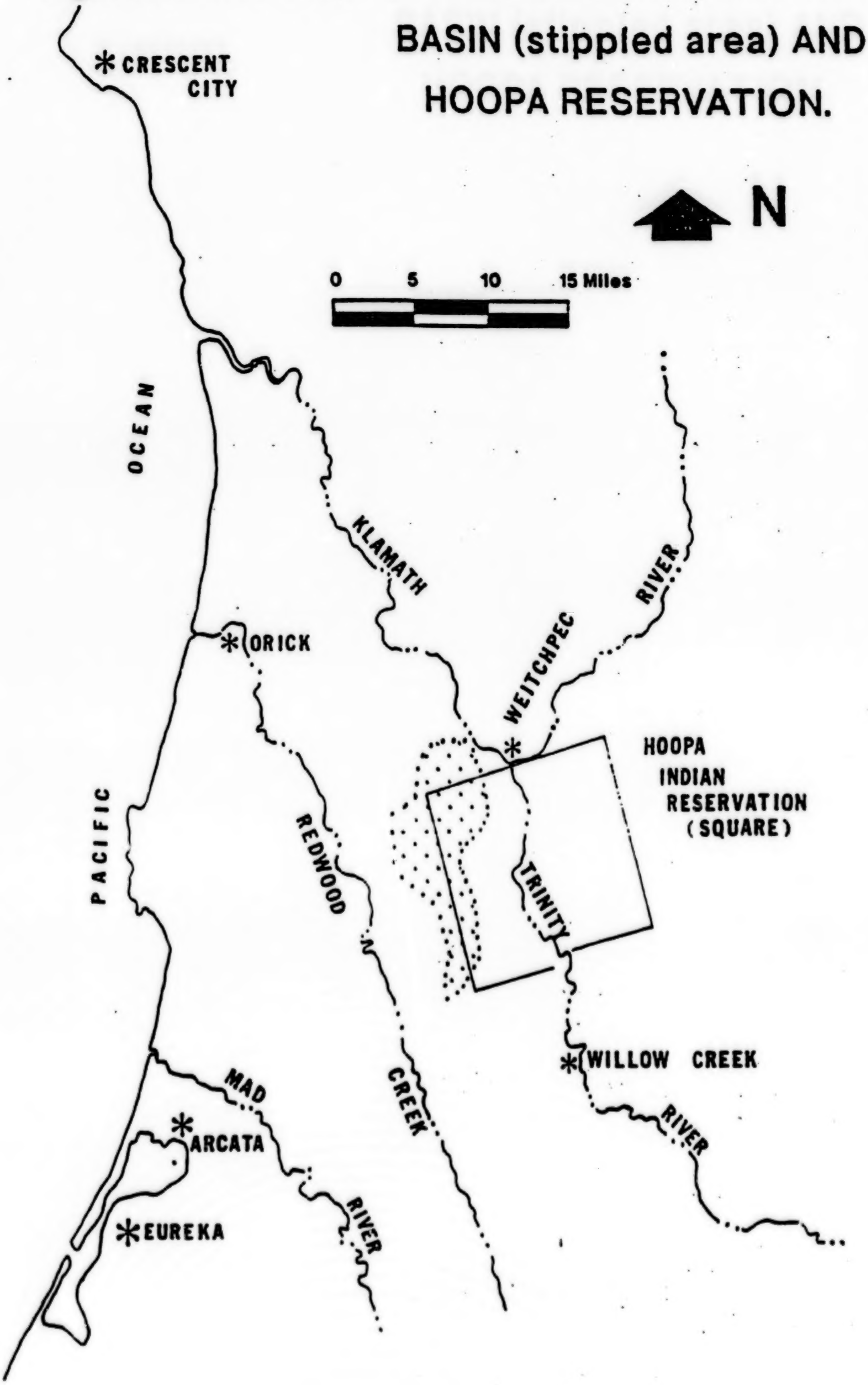
[1] Supplies/equipment purchased included: McNiel sampler, collection bottles, fence stakes, pvc pipe

Figure 1. LOCATION OF PINE CREEK DRAINAGE BASIN (stippled area) AND HOOPA RESERVATION.



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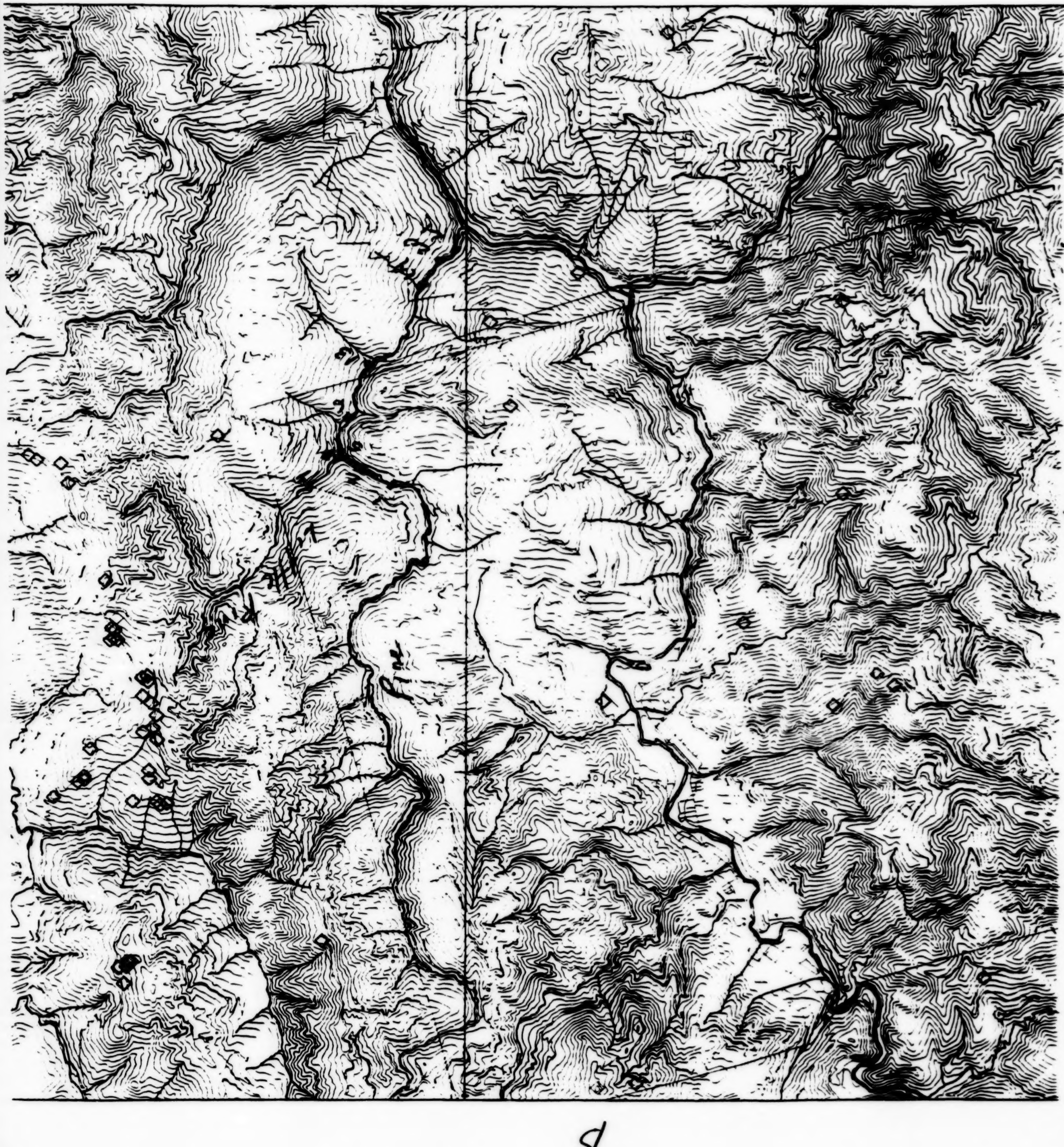

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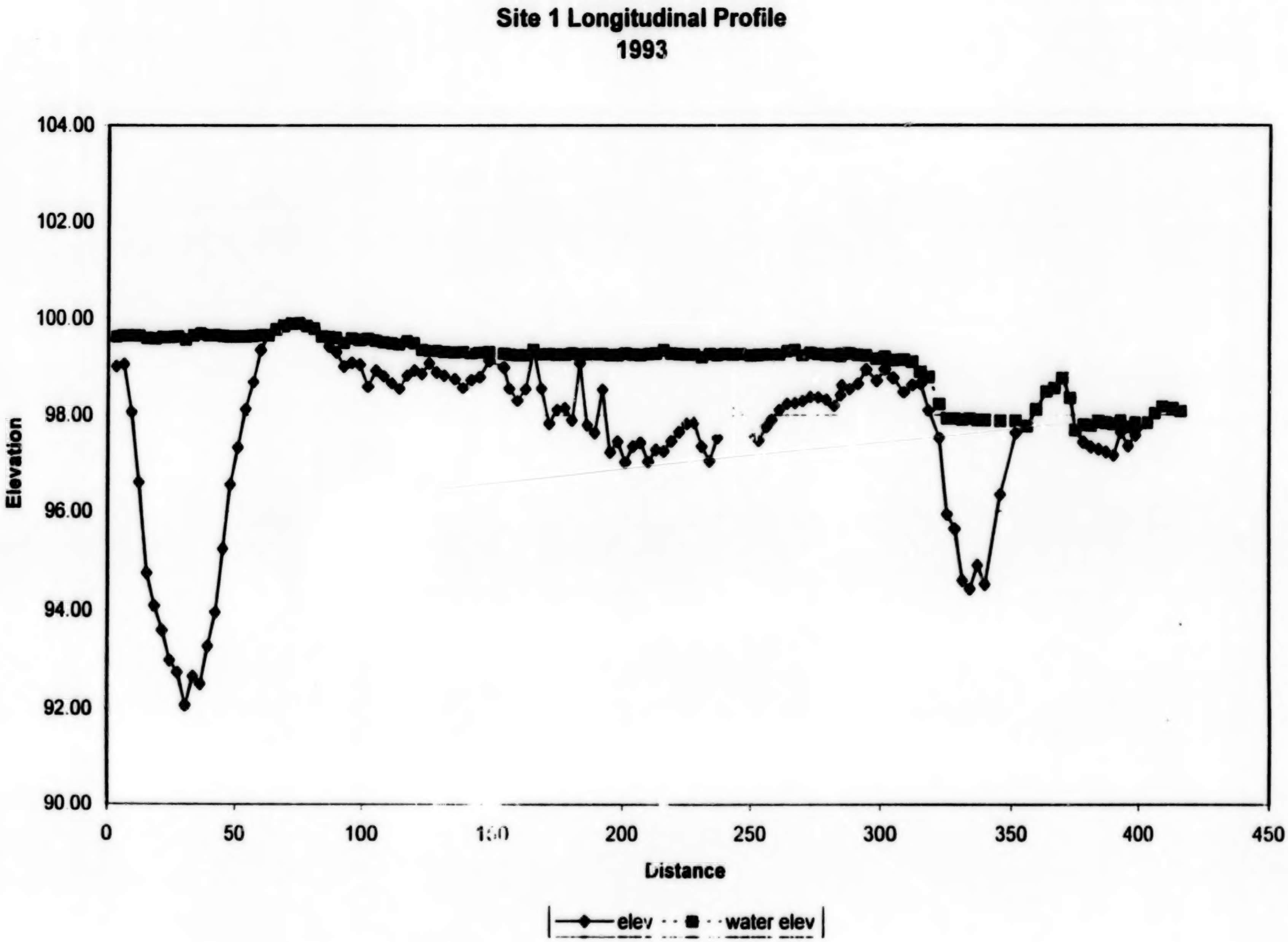
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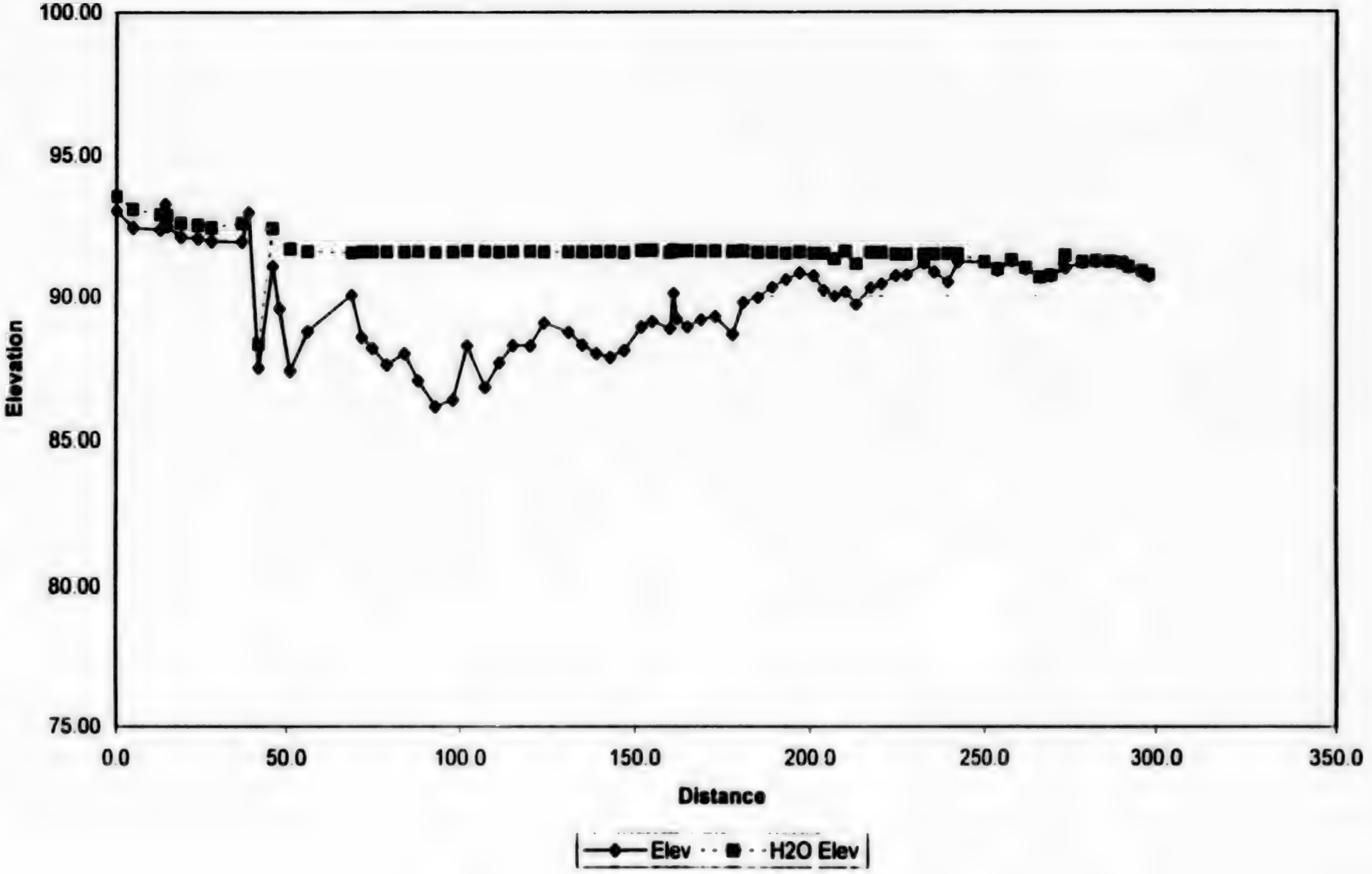
water elev

Site 3 Longitudinal Profile
1993



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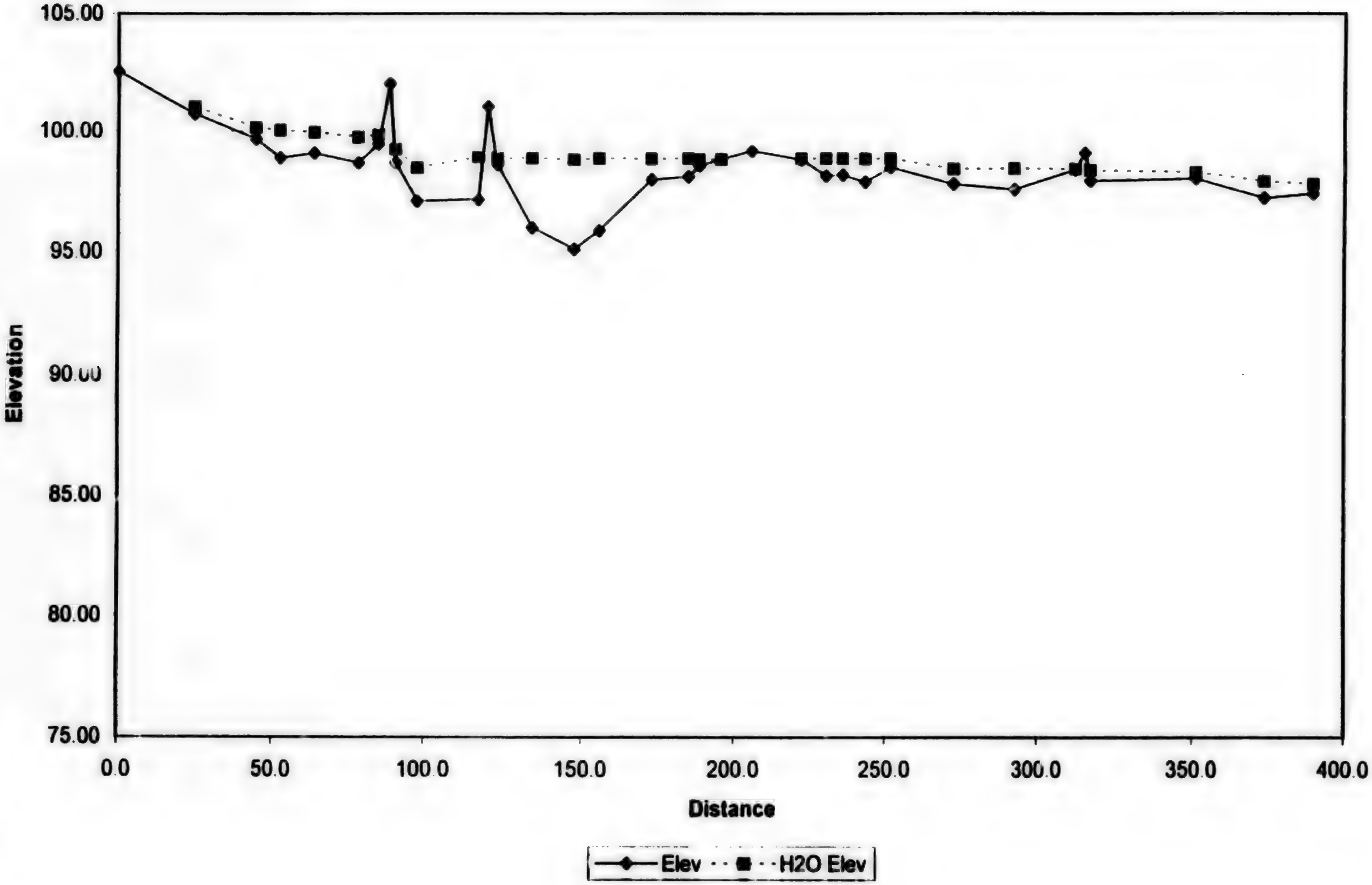
1992



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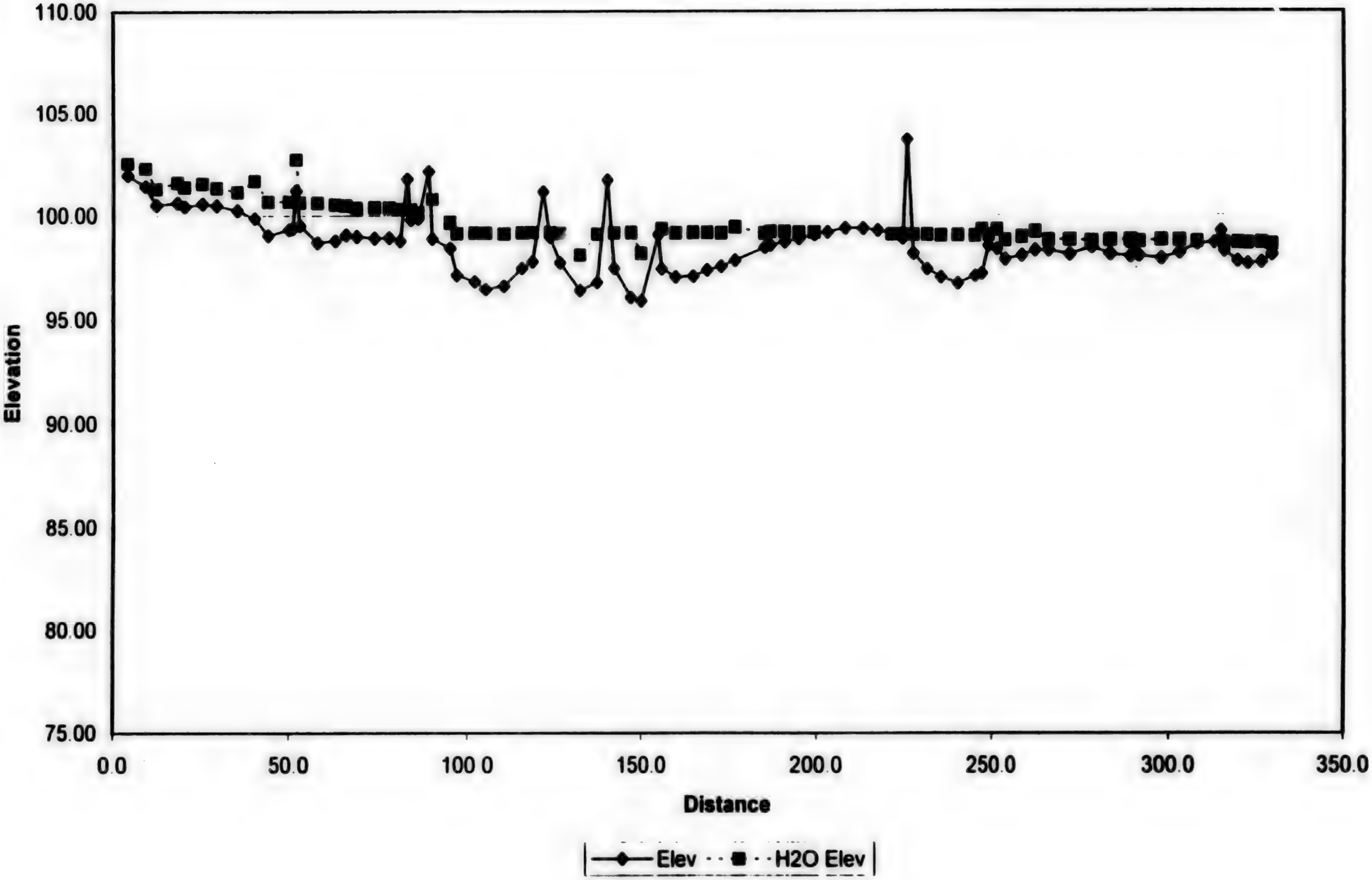
1993



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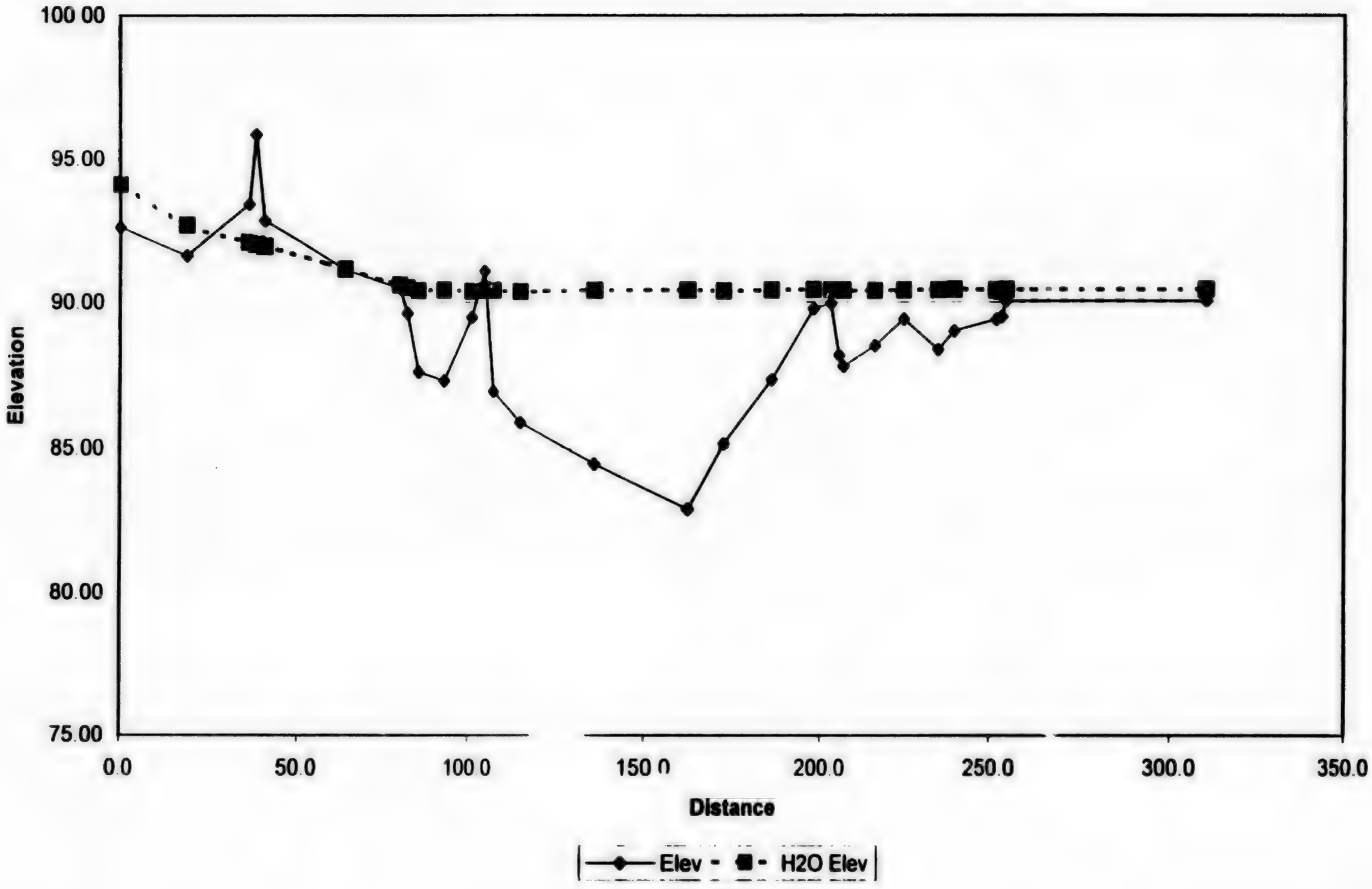
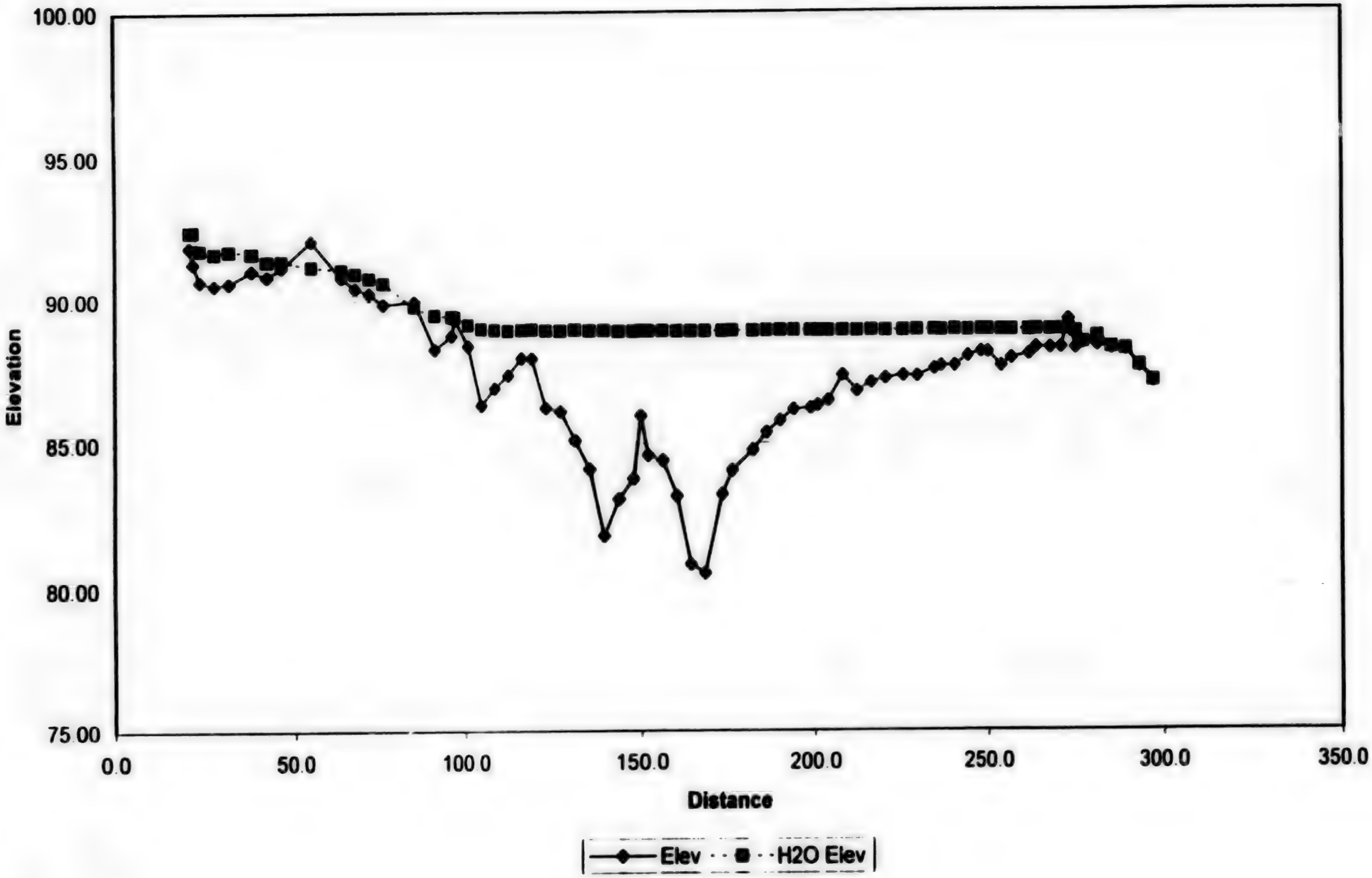
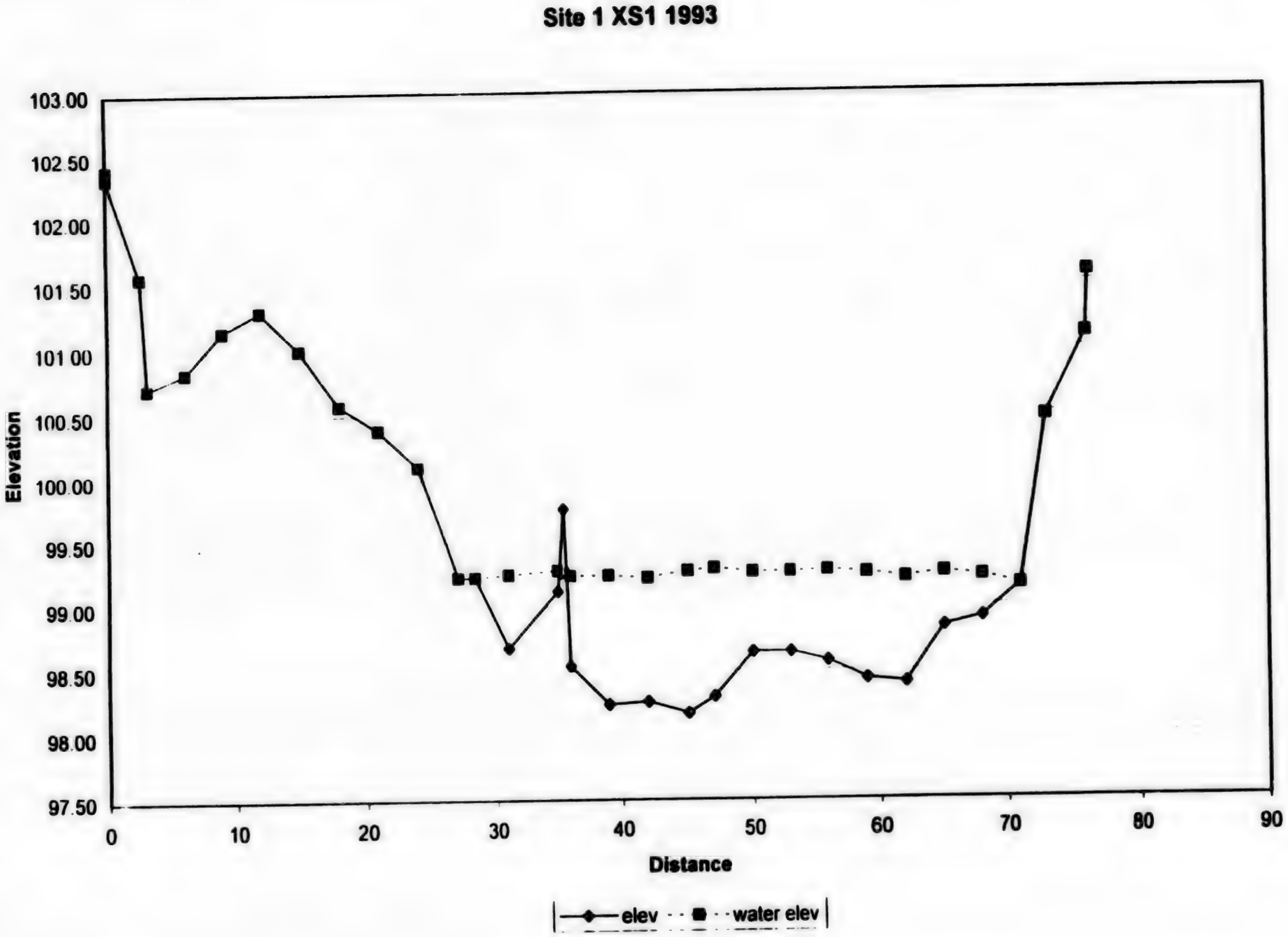
Site 19 Longitudinal Profile
1992



Site 19 Longitudinal Profile
1994

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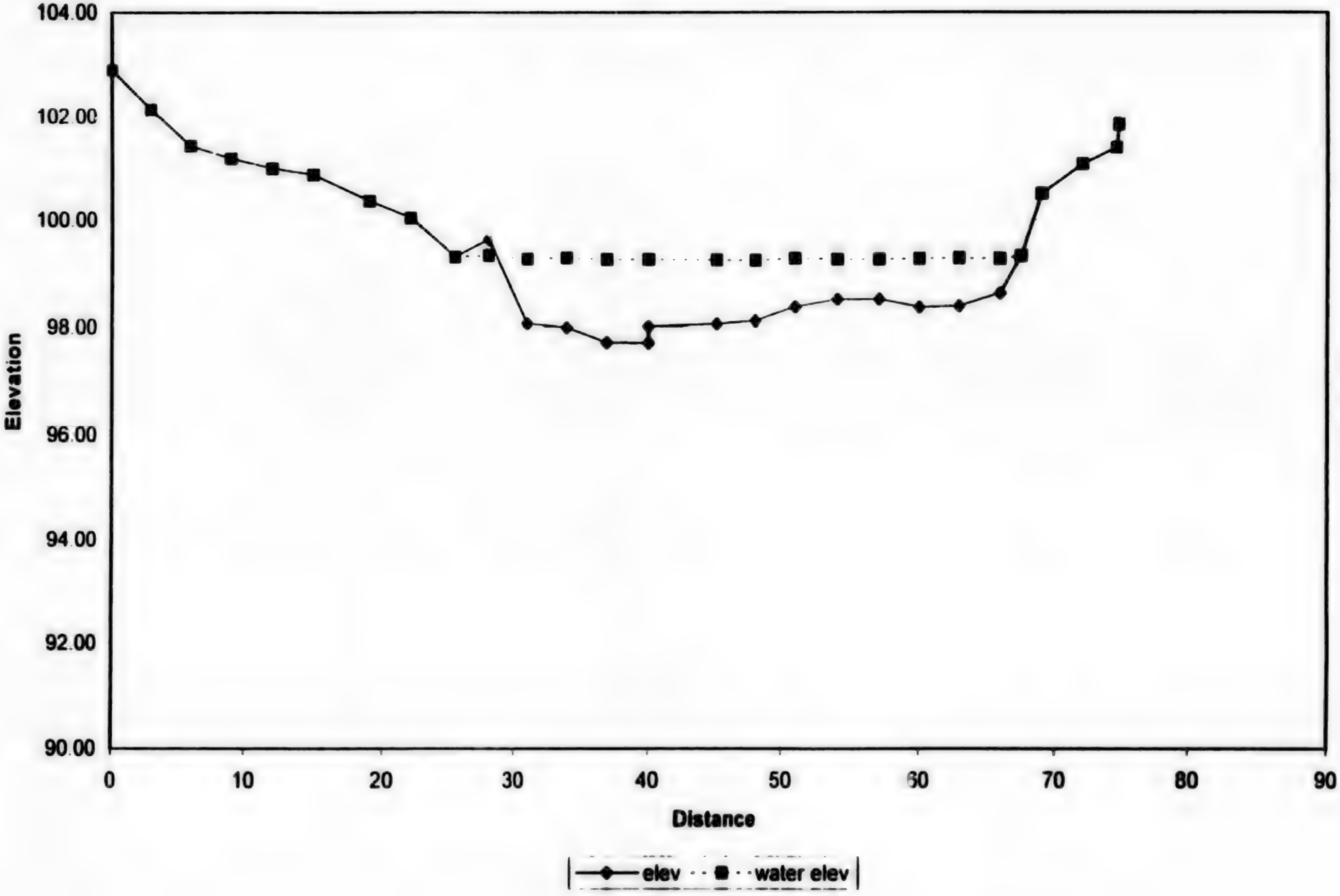
Site 1 XS2 1993



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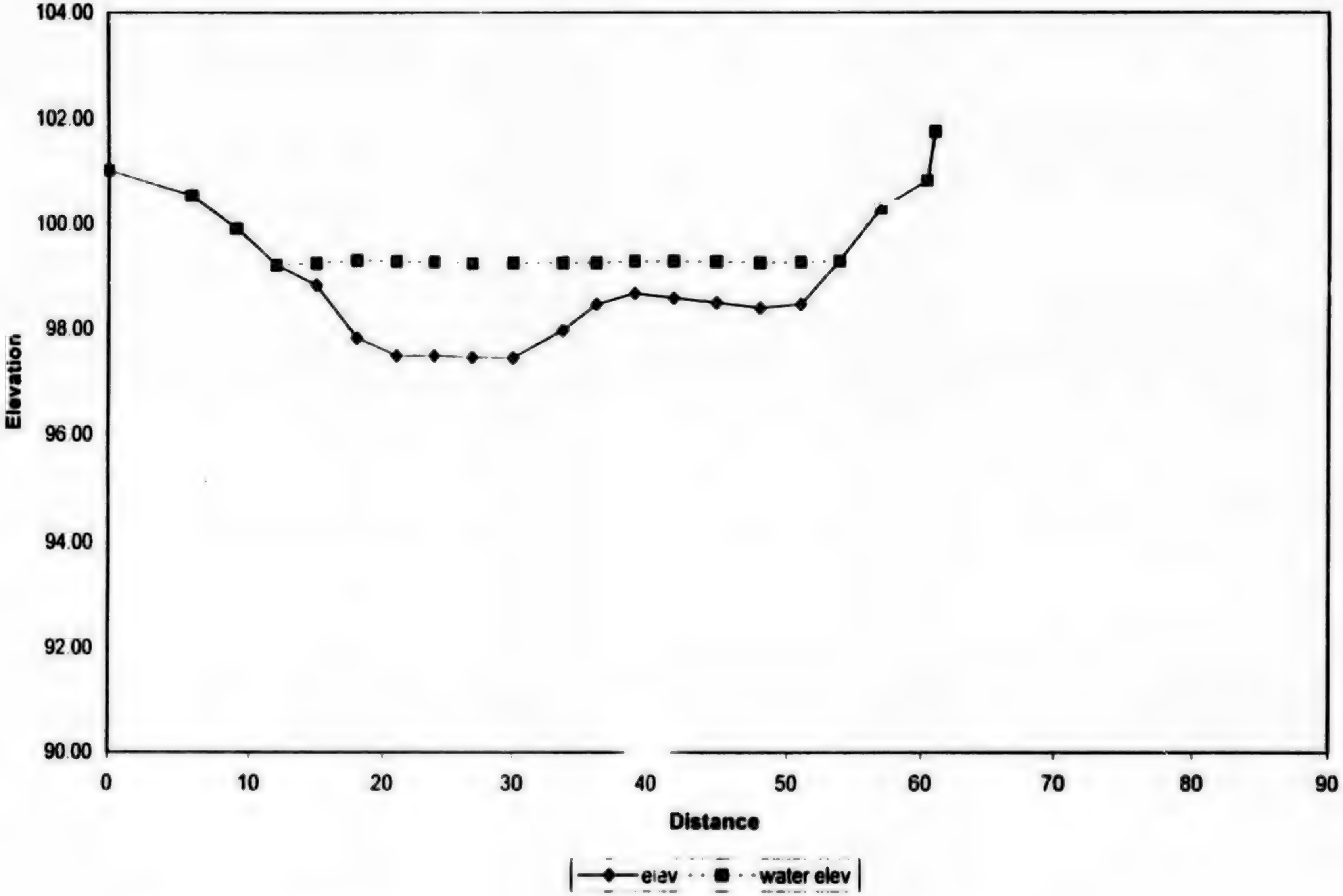

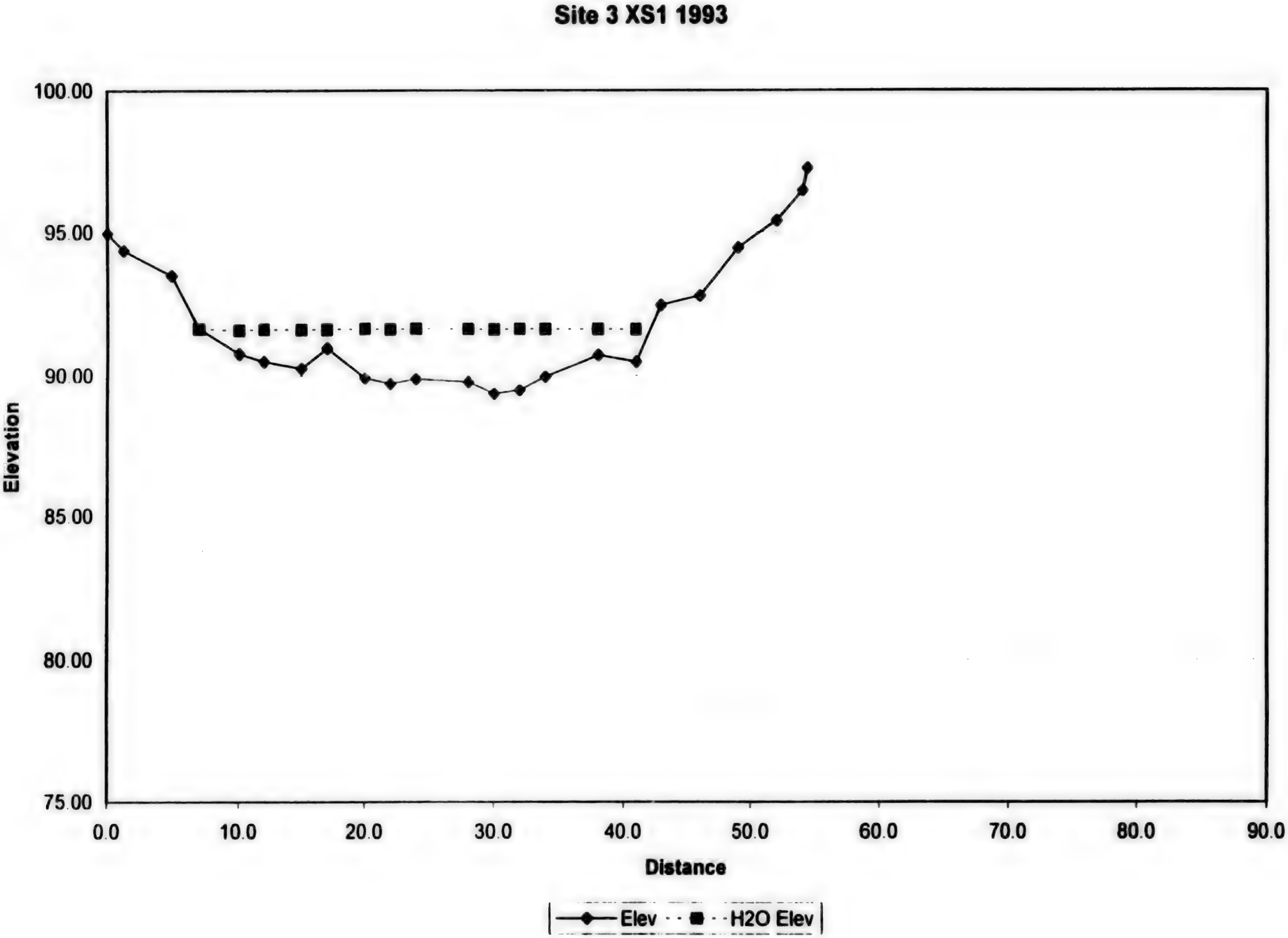
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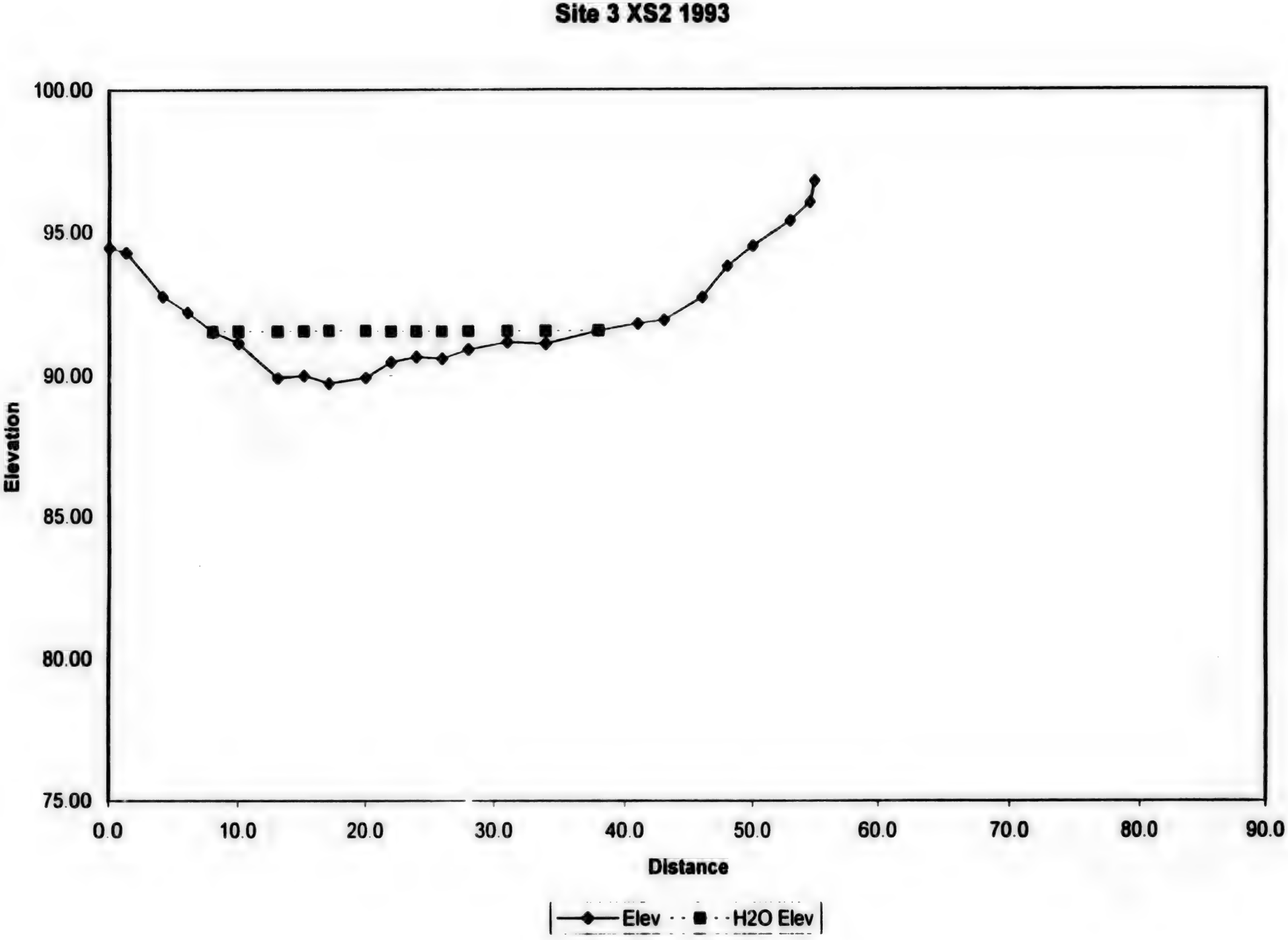
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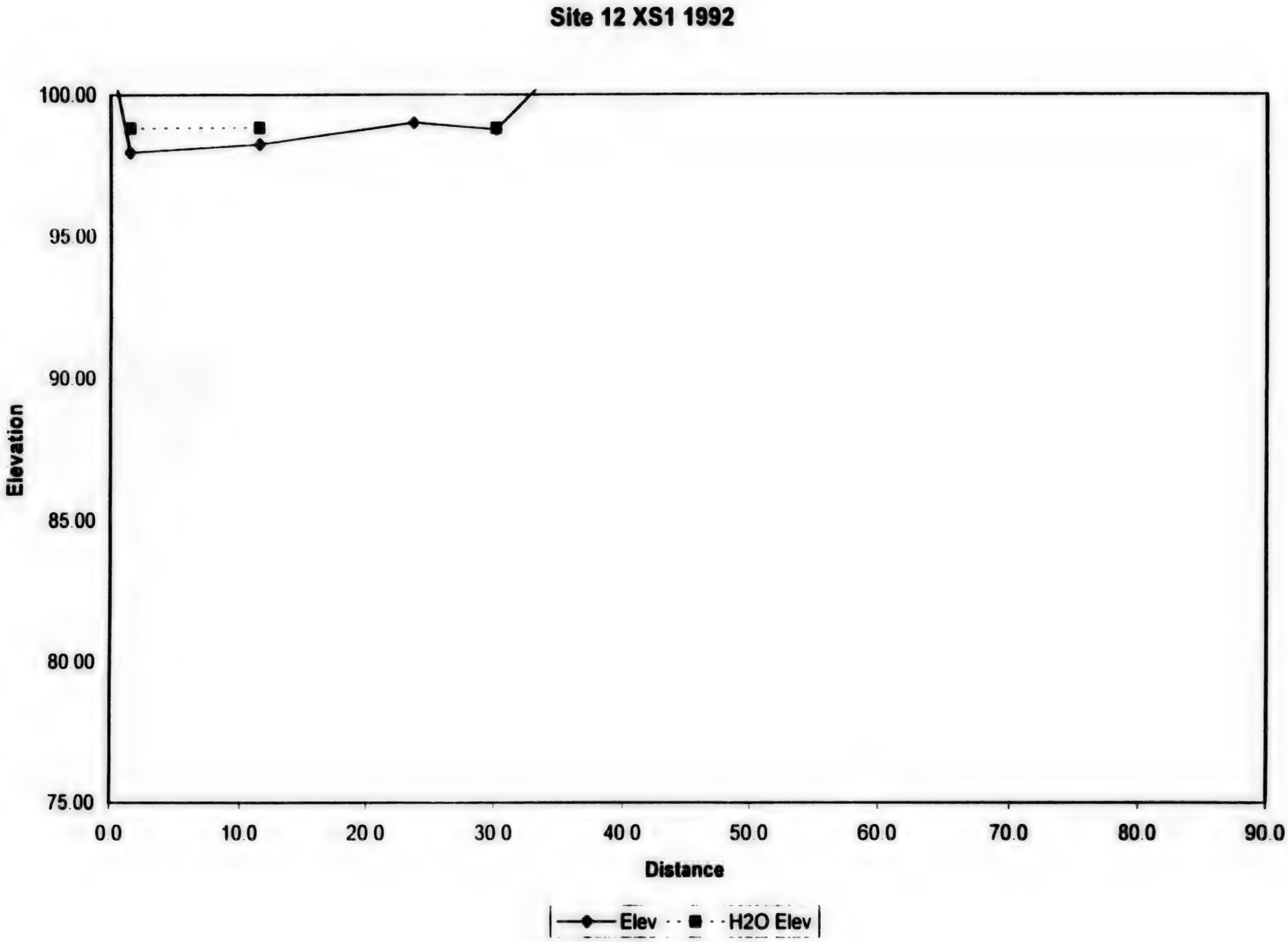
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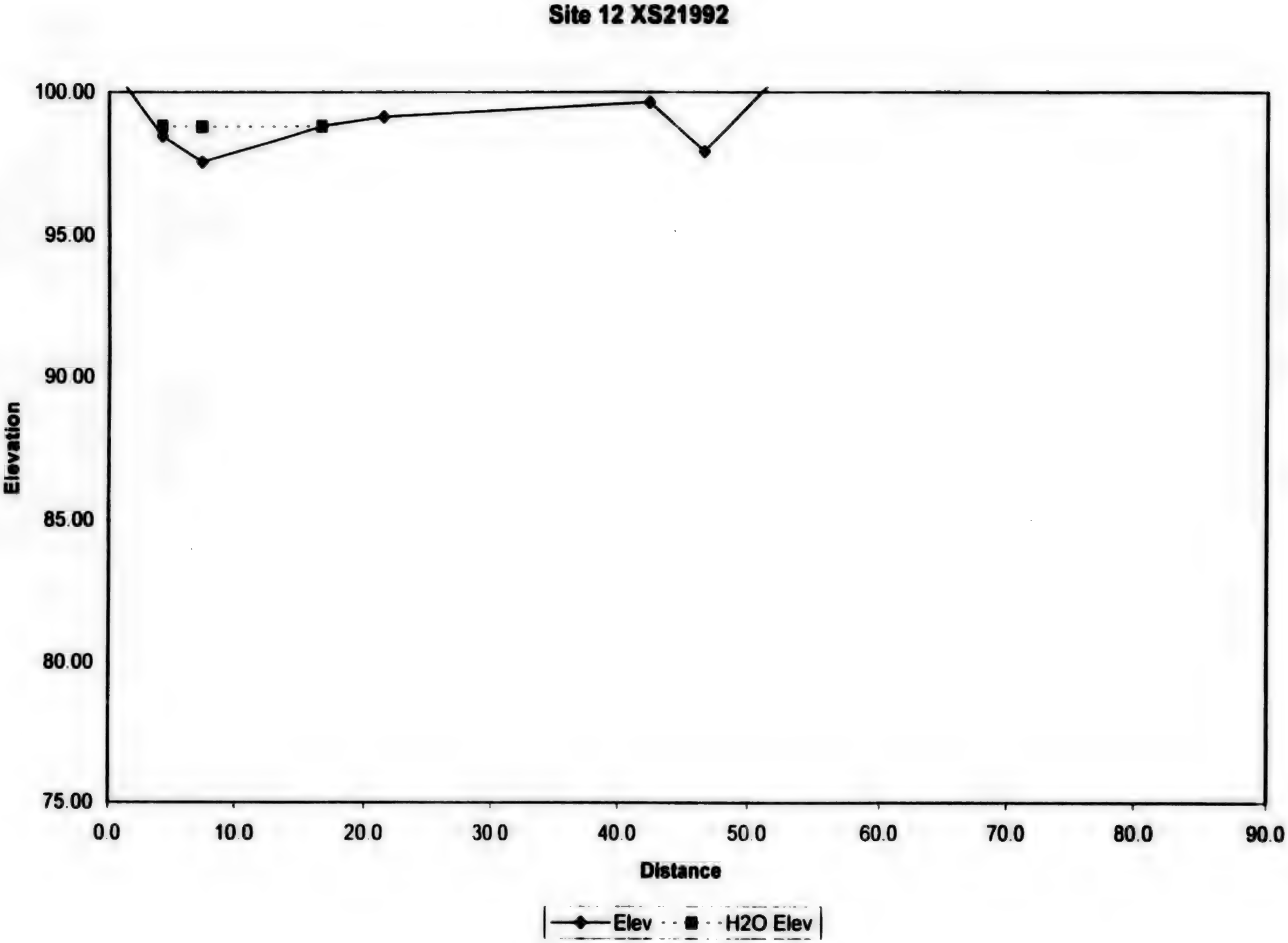
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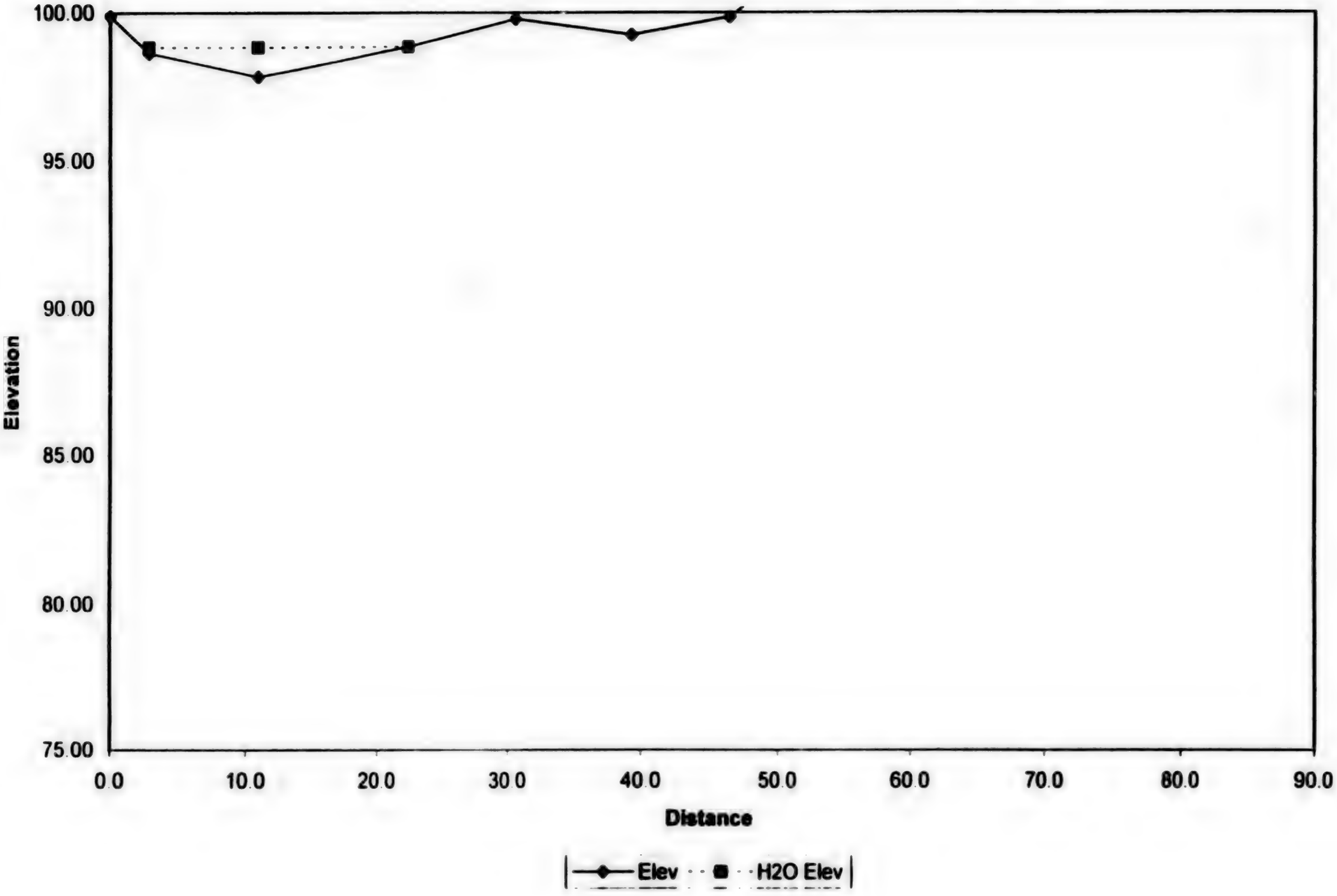
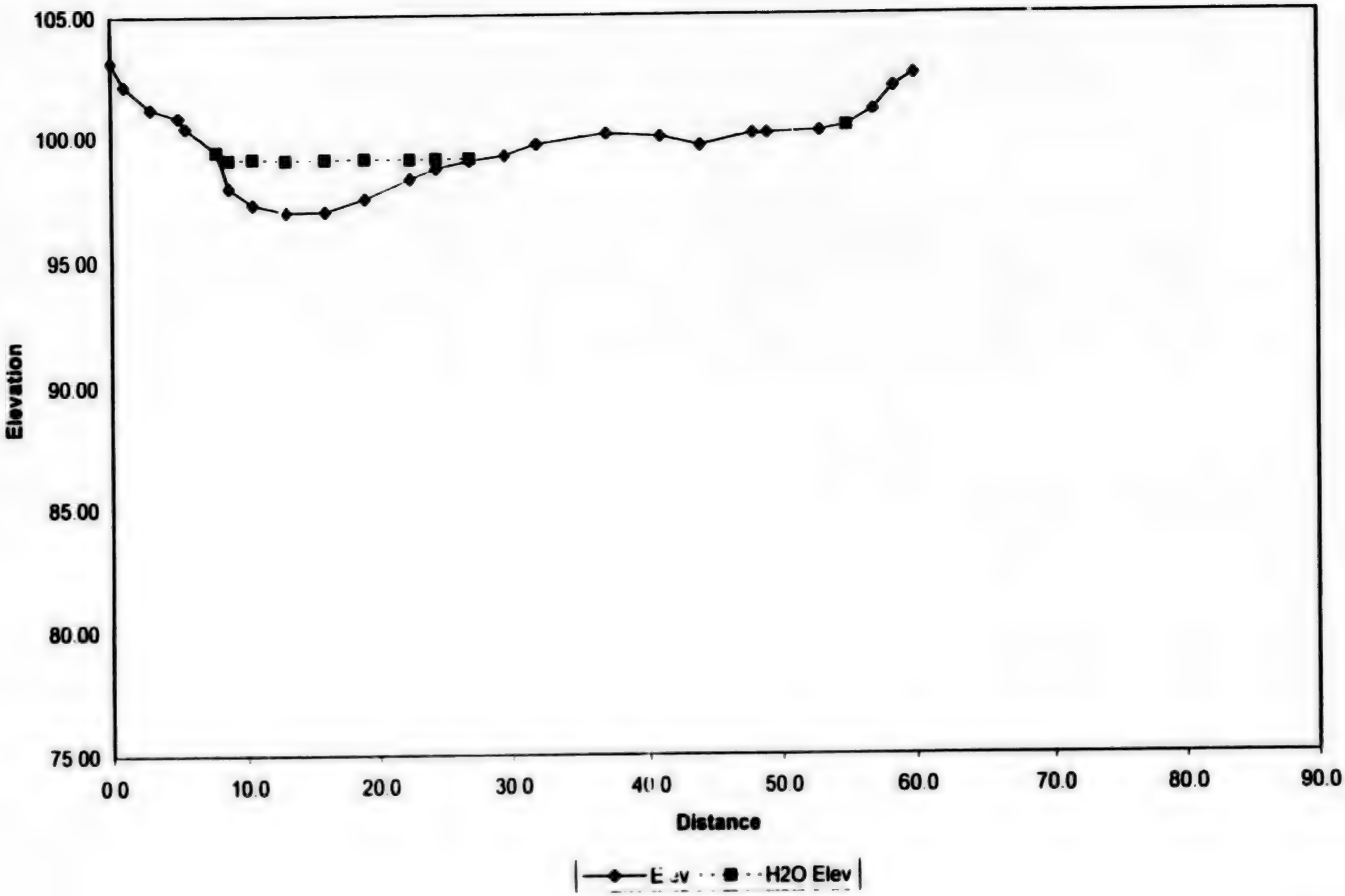
Site12 XS3 1992





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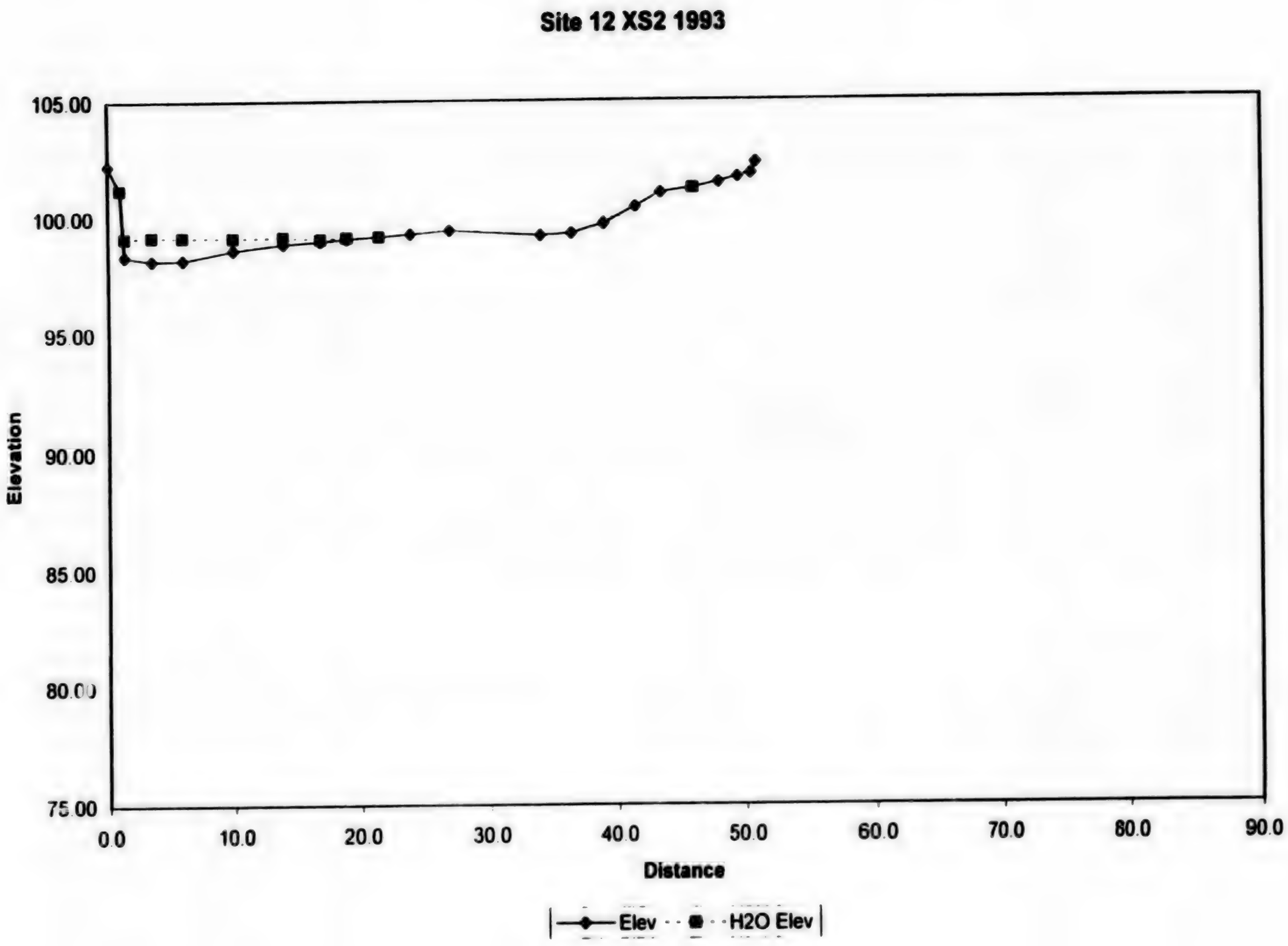
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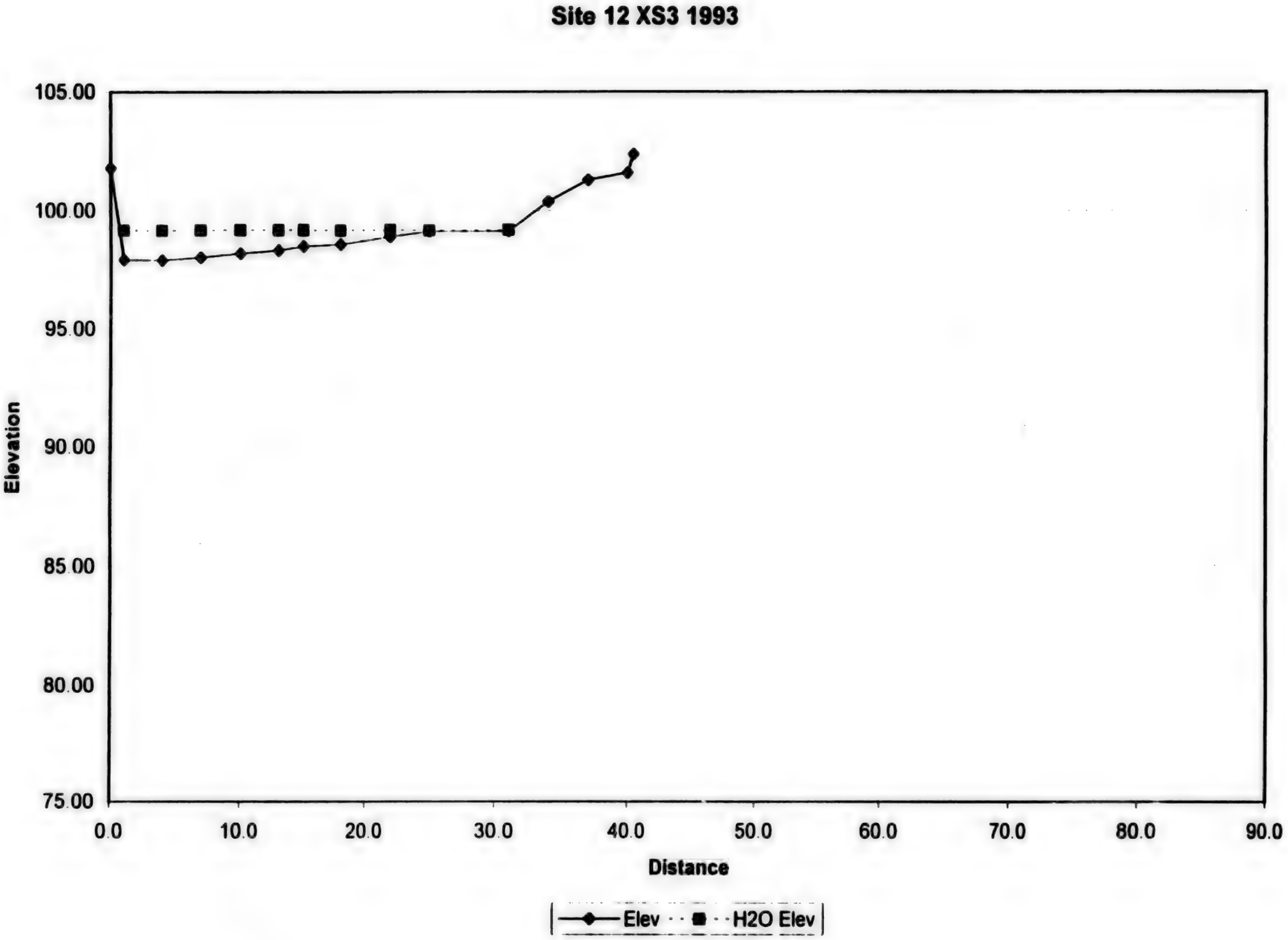
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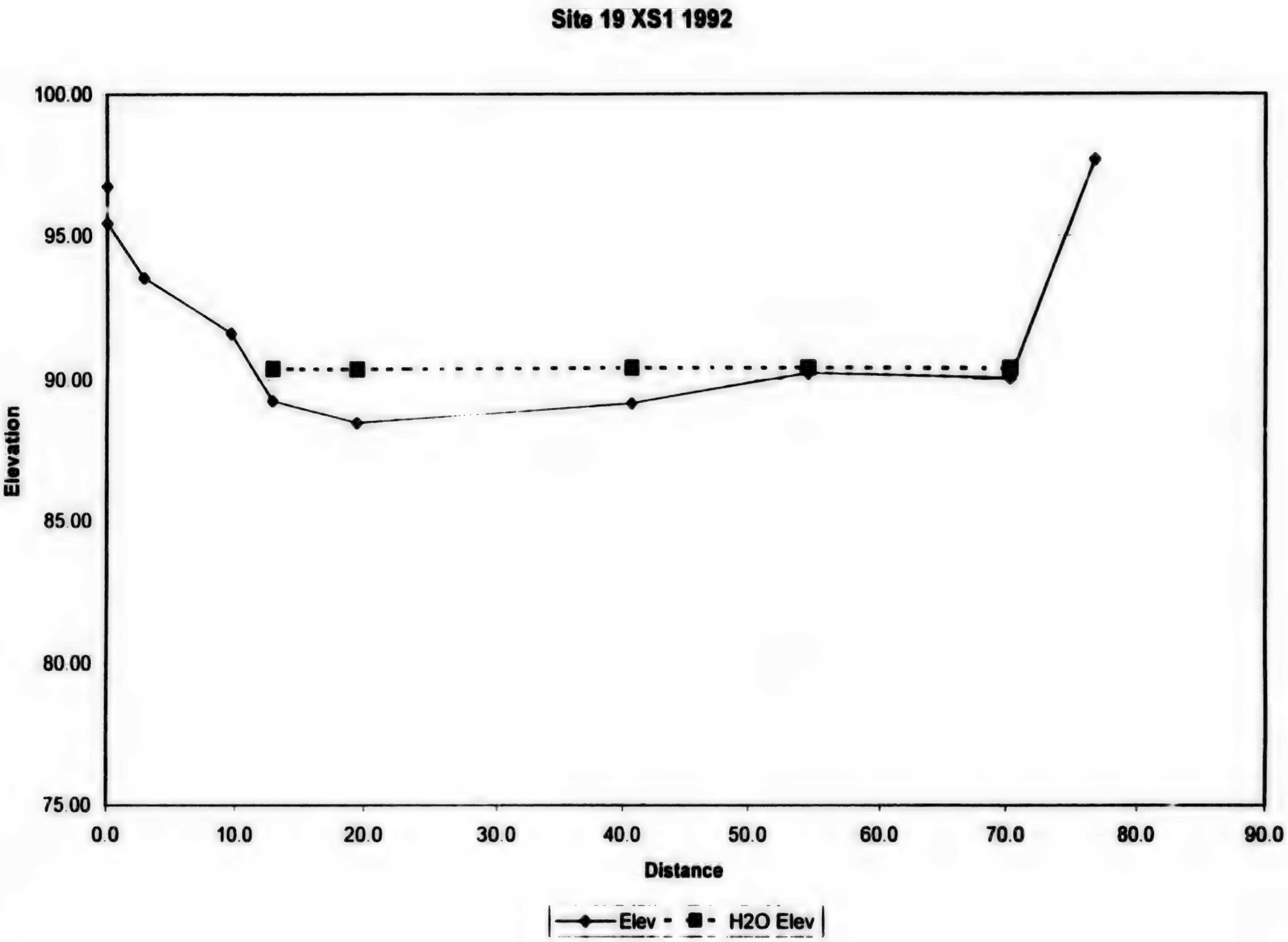

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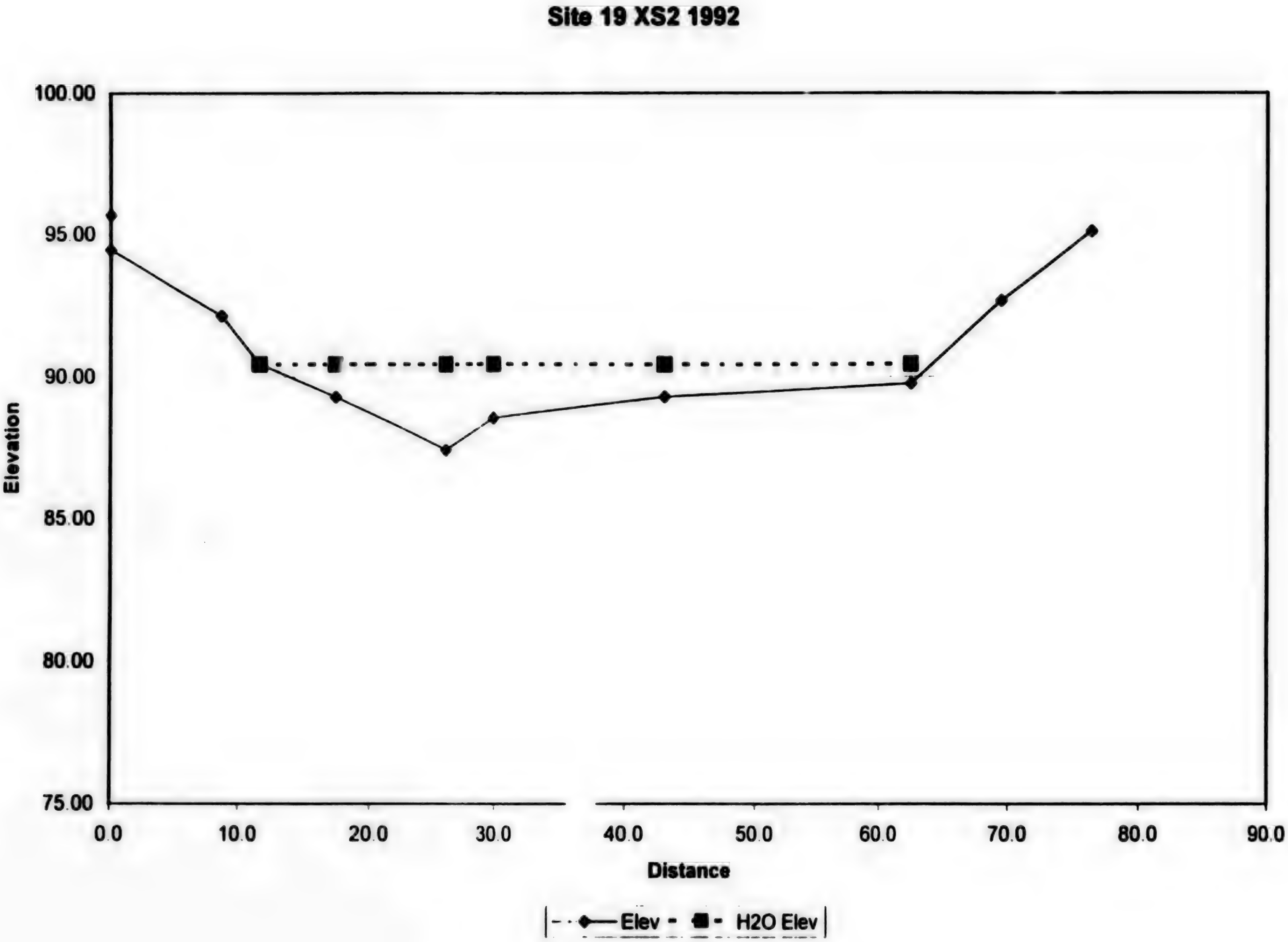
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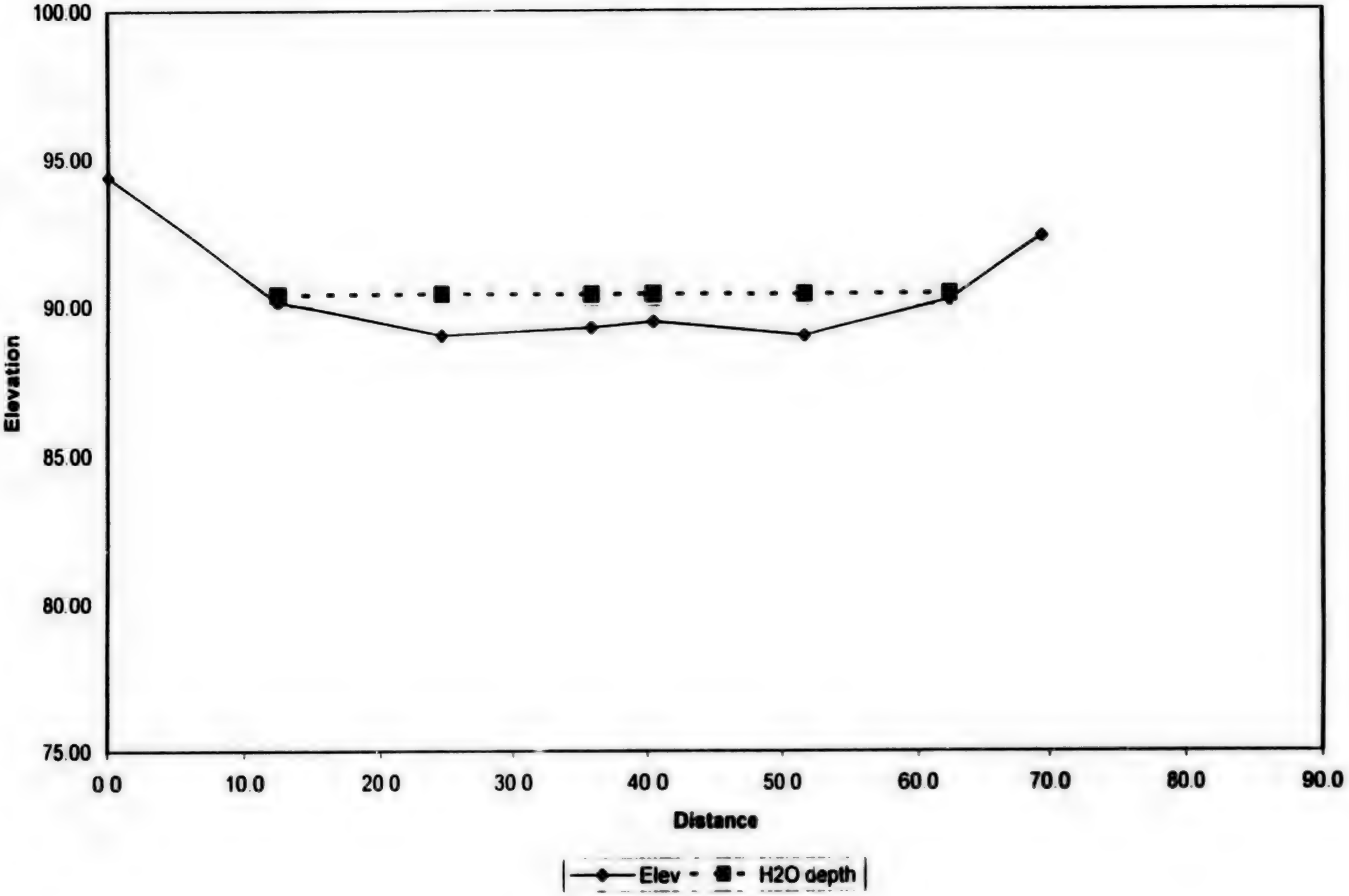

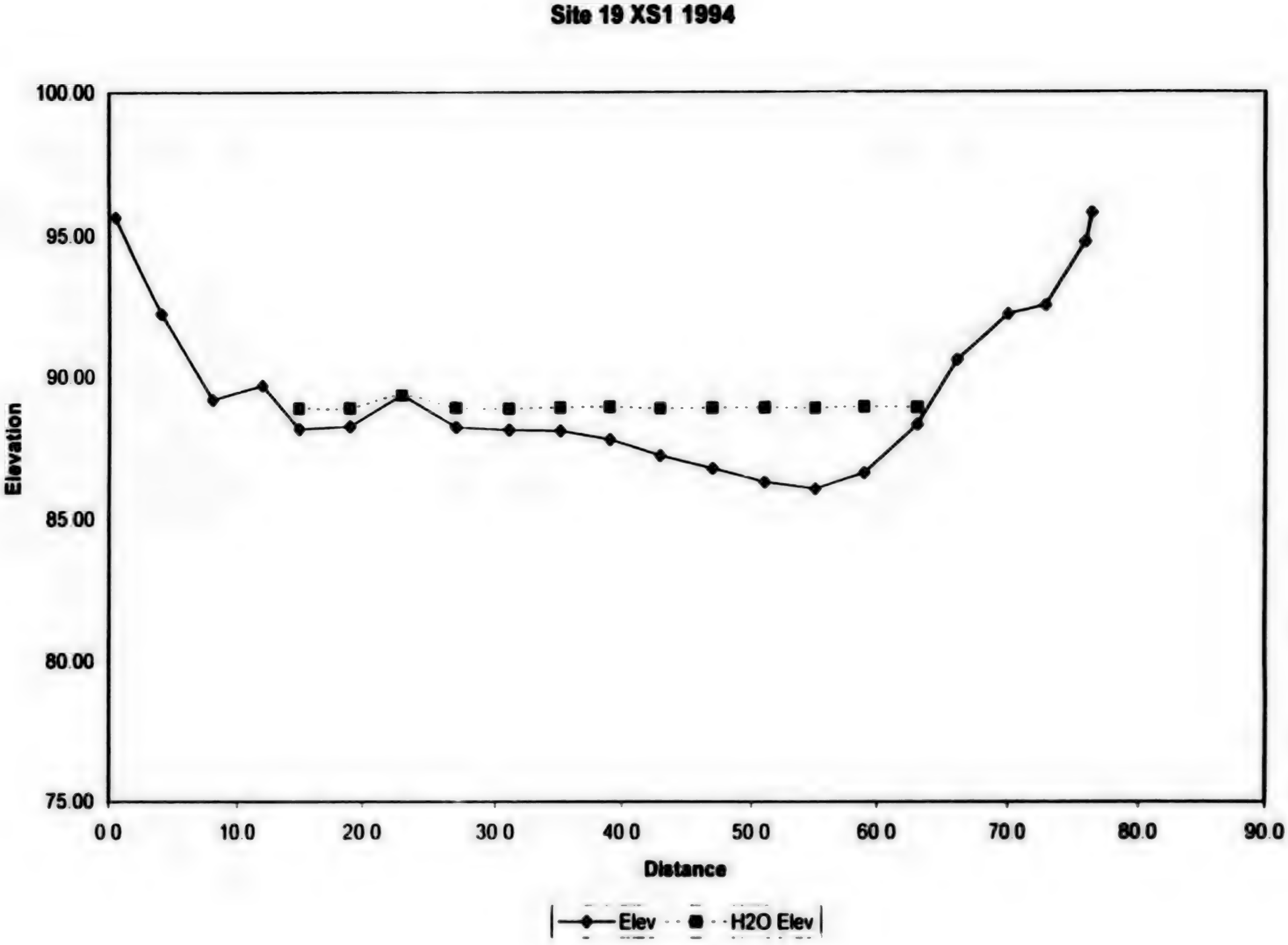
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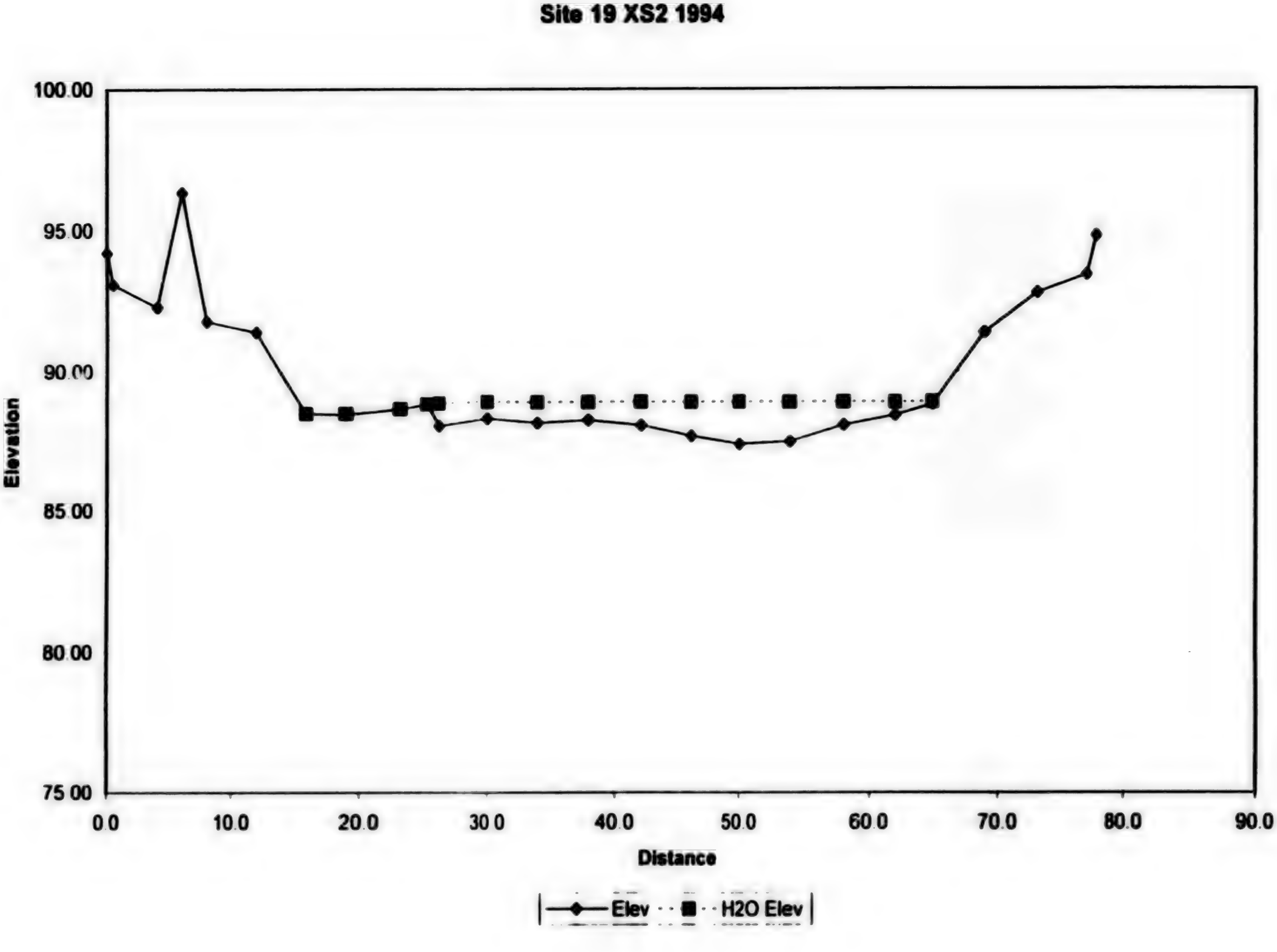
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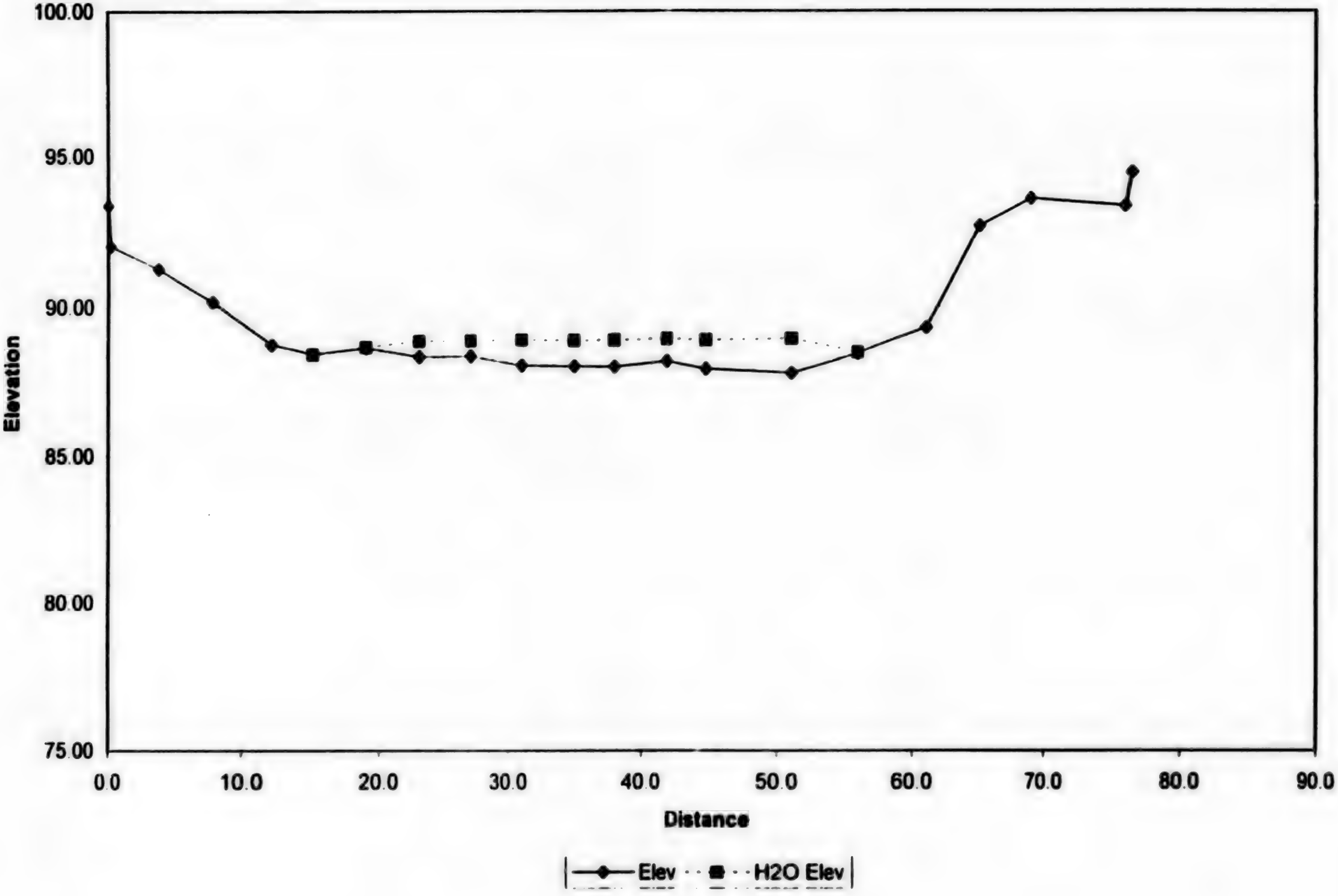

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  GEOMETRIC MEAN & PERCENT FINES BREAK DOWN FOR PINE1A
LLECTED :9/3/92
ERCENT FINES FOR THIS SAMPLE ARE BASED ON GRAIN SIZES <  1.000 mm

AMPLE  Dg1      Dg2     Percent     Percent of Sample retained by given Sieve
 #     mm       mm       Fines       <.125      <1.0       <4.0      <32.0      <100

 1      7.77     5.50     11.88        1.65      10.24      26.96      50.40     10.76
 2      6.32     4.50     20.54        2.43      18.11      23.35      42.26     13.84
 3      8.29     5.17     18.47        5.50      12.97      16.32      41.51     23.71
 4      6.45     3.84     26.37        5.75      20.62      10.95      44.96     17.72

ERAGES FOR ALL  4  SAMPLES:

        7.21     4.75     19.31        3.83     15.48      19.40      44.78     16.51
SULTS FOR PINE1A                  COLLECTED : 9/3/92

          (<----QUALITY INDICES----><--DISTRIBUTION DESCRIPTORS---->)
AMPLE      GEOM.      SORT.      FREDLE     STANDARD      SKEW       KURTOSIS
 #         MEAN       COEF.      INDEX      DEV.
 1          7.77       2.584      3.005      4.1094       0.2013      0.6357
 2          6.32       3.443      1.836      6.1485       0.1120      0.4242
 3          8.29       4.023      2.062      6.9066       -.0061      0.5391
 4          6.45       4.804      1.343      8.5686       -.0233      0.3755

ERAGES      7.21       3.714      2.061      6.433        0.0710      0.4936

NDEX     SAMPLE n       MEAN         STANDARD DEV            95 % CONFID. INTRVL
 Dg          4          7.208           0.975                ( 5.658 -    8.758)
 So          4          3.714           0.937                ( 2.224 -    5.203)
 Fi          4          2.061           0.697                ( 0.953 -    3.170)

S TO EMERGENCE SURVIVAL RATES FOR STEELHEAD, COHO & CHINOOK SALMON BASED ON
 PERCENT CONFIDENCE INTERVALS for Dg & Fi

          Confidence Interval Ranges             Based on Average
            Lower           Higher                  Dg and Fi

ELHEAD      16.48 %   to    65.35 %                 48.32 % *

O           -6.60 %   to    46.61 %                 27.92 % *

NOOK         5.08 %   to    16.19 %                 10.32 %

STEELHEAD & COHO SURVIVAL RATES BASED ON Fi
CHINOOK SURVIVAL RATES BASED ON (Dg:Egg diameter) RELATIONSHIP


OMETRIC MEANS, STAND. DEV.'s, & PERCENTILES FOR PINE1A
LLECTED :9/3/92
PL #    Dg1       Sg       D5      D16       D25        D50        D75        D84        D95
--------------------------------------------------------------------------------------------
 1        7.77    4.11    0.38    1.34       2.19       5.84      14.61      22.60      38.35
 2        6.32    6.15    0.23    0.73       1.36       5.16      16.08      27.65      40.77
 3        8.29    8.61    0.12    0.75       1.85       8.39      29.92      35.71      45.68
 4        6.45    8.57    0.12    0.45       0.91       6.78      20.94      32.91      42.93

--------------------------------------------------------------------------------------------
erages for all  4  samples

          7.21    6.43    1.25    0.82       1.57       6.54      20.39      29.72      41.93
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    GEOMETRIC MEAN & PERCENT FINES BREAK DOWN FOR PINE18
COLLECTED :10/9/92
 PERCENT FINES FOR THIS SAMPLE ARE BASED ON GRAIN SIZES <  1.000 mm

 SAMPLE  Dg1      Dg2     Percent    Percent of Sample retained by given Sieve
   #     mm       mm       Fines      <.125      <1.0      <4.0     <32.0     <100

   1      9.13     5.18    18.47       7.83      10.64     16.34     30.05    35.13
   2      8.64     6.93    11.85       6.22       5.63     23.22     44.03    20.90
   3     10.41     6.95    13.61       6.49       7.12     17.22     37.84    31.32
   4      5.08     3.01    17.79       4.58      13.21     23.60     51.76     1.65

AVERAGES FOR ALL  4  SAMPLES:

          8.32     5.52    15.43       6.28       9.15     21.40     40.92    22.25
RESULTS FOR PINE18                  COLLECTED : 10/9/92

            |<----QUALITY INDICES----||<--DISTRIBUTION DESCRIPTORS---->|
 SAMPLE     GEOM.     SORT.      FREDLE   STANDARD     SKEW      KURTOSIS
   #        MEAN      COEF       INDEX    DEV
   1          9.13     4.380      2.085    7.6361     -.1119     0.5296
   2          8.64     3.225      2.678    4.9710     0.0642     0.8666
   3         10.41     3.594      2.897    6.6309     -.0575     0.7814
   4          5.08     2.317      2.193    3.6465     0.1234     0.9071

AVERAGES      8.32     3.379      2.463    5.446      0.0046     0.7712

 INDEX     SAMPLE n     MEAN       STANDARD DEV           95 % CONFID. INTRVL
  DG          4         8.316        2.281               (  4.689 -  11.944)
  SO          4         3.379        0.856               (  2.018 -   4.740)
  FI          4         2.463        0.387               (  1.847 -   3.080)

EGG TO EMERGENCE SURVIVAL RATES FOR STEELHEAD, COHO & CHINOOK SALMON BASED ON
95 PERCENT CONFIDENCE INTERVALS for Dg & Fi

           Confidence Interval Ranges          Based on Average
             Lower          Higher               Dg and Fi

STEELHEAD     43.88 %   TO   64.33 %              55.46 % *

COHO          23.15 %   TO   45.35 %              35.65 % *

CHINOOK        4.43 %   TO   33.50 %              18.49 %

 * STEELHEAD & COHO SURVIVAL RATES BASED ON Fi
   CHINOOK SURVIVAL RATES BASED ON (Dg/Egg diameter) RELATIONSHIP


GEOMETRIC MEANS, STAND. DEV.'s, & PERCENTILES FOR PINE18
COLLECTED : 10/9/92
SMPL #   Dg       Sg      D5     D16      D25       D50       D75       D84      D95
-------------------------------------------------------------------------------------
   1      9.13    7.64   0.10   0.68      1.85     11.46     35.41     39.57    49.39
   2      8.64    4.97   0.11   1.39      2.42      7.79     25.21     34.44    46.44
   3     10.41    5.53   0.11   1.26      2.65     11.49     34.25     38.42    48.30
   4      5.08    3.65   0.14   0.82      1.51      4.33      8.13     10.97    19.93

-------------------------------------------------------------------------------------
Averages for all  4  samples

          8.32    5.45   1.25   1.04      2.11      8.77     25.75     30.85    40.51
   GEOMETRIC MEAN & PERCENT FINES BREAK DOWN FOR PINE1C
OLLECTED :10/14/93
PERCENT FINES FOR THIS SAMPLE ARE BASED ON GRAIN SIZES <  1.000 mm

SAMPLE  Dg1     Dg2     Percent     Percent of Sample retained by given Sieve
  #     mm      mm      Fines      <.125     <1.0      <4.0     <32.0     <100

  1     6.81    4.60    14.83       2.36     12.47     26.22     50.40     8.55
  2     4.16    2.19    20.34       2.85     17.49     35.28     44.38     0.00
  3    43.96   32.73     2.21       1.44      0.77      0.77     18.78    78.23
  4    19.32   12.70    10.99       2.16      8.83      5.28     37.30    46.43
  5     7.28    5.50    14.55       1.62     12.93     27.55     44.20    13.70
  6    12.29    7.79    11.90       3.22      8.68     14.63     43.41    30.05
  7    18.78   10.75     3.60       1.30      2.31     21.61     26.89    47.90

AVERAGES FOR ALL  7  SAMPLES:

       16.08   10.89    11.20       2.14      9.07     18.76     37.91    32.12
RESULTS FOR PINE1C              COLLECTED : 10/14/93

          <-----QUALITY INDICES-----><----DISTRIBUTION DESCRIPTORS----->
SAMPLE     GEOM.      SORT.     FREDLE    STANDARD     SKEW      KURTOSIS
  #        MEAN       COEF.     INDEX     DEV
  1         6.81      2.628      2.590    4.2510     0.1685     0.6928
  2         4.16      2.097      1.986    3.0233     0.2163     0.7274
  3        43.96      1.188     36.996    1.5391     0.2749     1.5851
  4        19.32      2.298      8.406    3.3620     -.2739     1.0646
  5         7.28      2.976      2.445    5.0079     0.1710     0.4936
  6        12.29      3.091      3.976    4.6756     -.0074     0.6633
  7        18.78      3.133      5.995    4.0064     -.2755     0.3534

AVERAGES   16.08      2.487      8.913    3.724      0.0391     0.7877

INDEX    SAMPLE n       MEAN      STANDARD DEV          95 % CONFID. INTRVL
 DG         7          16.085       13.632             (  3.461 -  28.709)
 SO         7           2.487        0.697             (  1.842 -   3.133)
 FI         7           8.913       12.494             (  0.000 -  20.476)

EGG TO EMERGENCE SURVIVAL RATES FOR STEELHEAD, COHO & CHINOOK SALMON BASED ON
95 PERCENT CONFIDENCE INTERVALS for Dg & FI

            Confidence Interval Ranges          Based on Average
              Lower          Higher               Dg and FI

TEELHEAD     43.88 %    to   95.00 %              95.00 % *

OHO          23.16 %    to   95.00 %              91.50 % *

HINOOK        2.36 %    to   94.17 %              56.61 %

* STEELHEAD & COHO SURVIVAL RATES BASED ON FI
  CHINOOK SURVIVAL RATES BASED ON (Dg/Egg diameter) RELATIONSHIP


GEOMETRIC MEANS, STAND. DEV.'s, & PERCENTILES FOR PINE1C
COLLECTED :10/14/93
SMPL #   Dg1      Sd     D5    D16     D25      D50      D75      D84      D95
--------------------------------------------------------------------------------
   1      6.81   4.25  0.27  1.08     1.86     5.33    12.85    19.53    36.41
   2      4.16   3.02  0.21  0.72     1.25     3.28     5.48     6.62     9.65
   3     43.96   1.54  6.39 *21.27    32.86    39.05    46.40    50.38    59.35
         19.32   3.36  0.35  2.78     7.30    26.93    38.54    42.58    62.37
```

```
[illegible]  12.29   4.98  0.25  1.60   [illegible]  12.43  [illegible]  [illegible]  [illegible]
7      18.78   4.01  1:23  2.68    3.97  27.52  38.92  43.06  52.67

--------------------------------------------------------------------
verages for all  7  samples

       16.08   3.72  1.14  4.60    7.52  17.15  27.49  32.54  42.72
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   GEOMETRIC MEAN & PERCENT FINES BREAK DOWN FOR PINE2
LLECTED :7/1/92
ERCENT FINES FOR THIS SAMPLE ARE BASED ON GRAIN SIZES <   1.000 mm

AMPLE  Dg1      Dg2     Percent     Percent of Sample retained by given Sieve
  #    mm       mm       Fines      <.125      <1.0      <4.0     <32.0     <100

  1     9.92    5.97    16.53       3.81      12.72     16.09     38.25    29.13
  2     8.20    5.37    16.16       5.11      11.05     15.27     54.12    14.45
  3     7.08    5.00    18.20       3.39      14.80     21.50     45.12    15.18
  4     6.09    4.84    17.63       3.99      13.64     28.61     39.88    13.88

VERAGES FOR ALL  4  SAMPLES:

        7.83    5.30    17.13       4.08      13.05     20.37     44.34    18.16
ESULTS FOR PINE2                 COLLECTED : 7/1/92

         !<----QUALITY INDICES---->!<--DISTRIBUTION DESCRIPTORS---->!
SAMPLE     GEOM.     SORT.     FREDLE    STANDARD      SKEW       KURTOSIS
  #        MEAN      COEF.     INDEX      DEV.
  1         9.92     3.889      2.551    6.3047      -.0165      0.5125
  2         8.20     2.844      2.884    5.4825      0.0403      0.7066
  3         7.08     3.309      2.141    6.0747      0.0841      0.4867
  4         6.09     3.191      1.909    5.6898      0.1470      0.5768

VERAGES     7.83     3.308      2.371    5.888       0.0637      0.5707

NDEX      SAMPLE n      MEAN       STANDARD DEV           95 % CONFID. INTRVL
 DG           4         7.825         1.641               (  5.216 -  10.434)
 SO           4         3.308         0.435               (  2.617 -   3.999)
 FI           4         2.371         0.433               (  1.683 -   3.059)

G TO EMERGENCE SURVIVAL RATES FOR STEELHEAD, COHO & CHINOOK SALMON BASED ON
 PERCENT CONFIDENCE INTERVALS for Dg & Fi

         Confidence Interval Ranges              Based on Average
            Lower          Higher                   Dg and Fi

ELHEAD      40.10 %   to   63.97 %                 53.94 % *

O           19.12 %   to   45.06 %                 34.00 % *

NOOK         5.33 %   to   24.21 %                 12.60 %

 STEELHEAD & COHO SURVIVAL RATES BASED ON FI
 CHINOOK SURVIVAL RATES BASED ON (Dg/Egg diameter) RELATIONSHIP


OMETRIC MEANS, STAND. DEV.'s, & PERCENTILES FOR PINE2
LLECTED :7/1/92
PL #    Dg1      Sd     D5    D16      D25       D50      D75      D84     D95
-------------------------------------------------------------------------------
  1       9.92   6.30  0.18  0.95      2.22     10.23    33.50    37.67   47.57
  2       8.20   5.48  0.12  0.98      2.36      7.66    19.07    29.46   41.18
  3       7.08   6.07  0.19  0.82      1.65      6.09    18.08    30.37   41.58
  4       6.09   5.69  0.17  0.85      1.53      4.72    15.58    27.54   40.85

-------------------------------------------------------------------------------
erages for all  4  samples

          7.83   5.89  1.25  0.90      1.94      7.17    21.56    31.26   42.80
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    GEOMETRIC MEAN & PERCENT FINES BREAK DOWN FOR PINE2B
COLLECTED :7/1/93
 PERCENT FINES FOR THIS SAMPLE ARE BASED ON GRAIN SIZES <  1.000 mm

 SAMPLE  Dg1      Dg2     Percent     Percent of Sample retained by given Sieve
   #     mm       mm       Fines      <.125      <1.0      <4.0     <32.0      <100

   1     7.81     4.91     21.55       1.88      19.67     15.12     44.00     19.33
   2     8.56     6.46     12.31       1.65      10.66     24.62     47.24     15.83
   3    10.40     7.63      9.31       1.24       8.07     24.81     43.46     22.42

AVERAGES FOR ALL  3  SAMPLES:

         8.92     6.34     14.39       1.59      12.80     21.52     44.90     19.19
RESULTS FOR PINE2B              COLLECTED : 7/1/93

           !<----QUALITY INDICES---->!<--DISTRIBUTION DESCRIPTORS---->!
 SAMPLE     GEOM.     SORT.     FREDLE    STANDARD     SKEW       KURTOSIS
   #        MEAN      COEF.     INDEX     DEV.
   1         7.81     4.033     1.936     6.8685      0.0434      0.3340
   2         8.56     2.919     2.932     4.9013      0.1560      0.4918
   3        10.40     3.207     3.243     4.6091      0.1385      0.4749

AVERAGES     8.92     3.387     2.704     5.460       0.1127      0.4336

 INDEX     SAMPLE n       MEAN       STANDARD DEV            95 % CONFID. INTRVL
   DG           3         8.923          1.336              (  5.607 -  12.239)
   SO           3         3.387          0.578              (  1.950 -   4.823)
   FI           3         2.704          0.683              (  1.008 -   4.400)

EGG TO EMERGENCE SURVIVAL RATES FOR STEELHEAD, COHO & CHINOOK SALMON BASED ON
 95 PERCENT CONFIDENCE INTERVALS for Dg & FI.

              Confidence Interval Ranges             Based on Average
                Lower              Higher               Dg and FI

STEELHEAD      18.82 %    to    77.74 %              59.14 % *

COHO           -3.17 %    to    60.84 %              39.70 % *

CHINOOK         5.99 %    to    35.32 %              16.82 %

 * STEELHEAD & COHO SURVIVAL RATES BASED ON FI
   CHINOOK SURVIVAL RATES BASED ON (Dg/Egg diameter) RELATIONSHIP


GEOMETRIC MEANS, STAND. DEV.'s, & PERCENTILES FOR PINE2B
COLLECTED :7/1/93
SMPL #    Dg1      Sd      D5     D16      D25       D50       D75       D84      D95
-------------------------------------------------/------------------------------------
   1       7.81    6.87   0.26   0.72      1.42      7.18     23.04     33.75    43.76
   2       8.56    4.90   0.37   1.32      2.25      6.68     19.16     31.66    41.93
   3      10.40    4.61   0.50   1.66      2.71      8.42     27.86     35.18    45.17

-------------------------------------------------------------------------------------
Averages for all  3  samples

           8.92    5.46   1.33   1.23      2.12      7.43     23.35     33.53    43.62
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  GEOMETRIC MEAN & PERCENT FINES BREAK DOWN FOR PINE2C
OLLECTED :7/1/94
PERCENT FINES FOR THIS SAMPLE ARE BASED ON GRAIN SIZES <  1.000 mm

SAMPLE  Dg1      Dg2     Percent    Percent of Sample retained by given Sieve
  #     mm       mm       Fines     <.125     <1.0     <4.0    <32.0     <100

  1    10.96    7.80     9.10       1.15      7.95    19.82    52.91   18.17
  2     9.39    6.51    13.69       2.11     11.58    21.41    42.35   22.54

VERAGES FOR ALL  2  SAMPLES:

       10.18    7.15    11.40       1.63      9.77    20.61    47.63   20.36
ESULTS FOR PINE2C              COLLECTED : 7/1/94

          !<----QUALITY INDICES---->!<--DISTRIBUTION DESCRIPTORS---->!
SAMPLE    GEOM.     SORT.    FREDLE   STANDARD     SKEW     KURTOSIS
  #       MEAN      COEF.    INDEX      DEV.
  1       10.96     2.660    4.122    4.2520     0.1527     0.5286
  2        9.39     3.520    2.668    5.4143     0.0886     0.4854

VERAGES   10.18     3.090    3.395    4.833      0.1207     0.5070

INDEX    SAMPLE n      MEAN      STANDARD DEV           95 % CONFID. INTRVL
  DG          2       10.177        1.113               ( 0.175 -  20.180)
  SO          2        3.090        0.608               ( 0.000 -   8.555)
  FI          2        3.395        1.028               ( 0.000 -  12.636)

GG TO EMERGENCE SURVIVAL RATES FOR STEELHEAD, COHO & CHINOOK SALMON BASED ON
5 PERCENT CONFIDENCE INTERVALS for Dg & FI.

          Confidence Interval Ranges           Based on Average
            Lower          Higher                 Dg and FI

EELHEAD     18.82 %   to   95.00 %               67.99 % *

HO          -3.17 %   to   95.00 %               49.58 % *

INOOK        0.11 %   to   74.91 %               22.63 %

 STEELHEAD & COHO SURVIVAL RATES BASED ON FI
 CHINOOK SURVIVAL RATES BASED ON (Dg/Egg diameter) RELATIONSHIP


EOMETRIC MEANS, STAND. DEV.'s, & PERCENTILES FOR PINE2C
OLLECTED :7/1/94
MPL #   Dg1      Sd     D5    D16     D25      D50     D75     D84     D95
---------------------------------------------------------------------------
  1    10.96   4.25   0.52   1.83    3.24     8.79   22.90   33.15   43.17
  2     9.39   5.41   0.30   1.20    2.26     8.09   27.97   35.25   45.23

---------------------------------------------------------------------------
verages for all  2  samples

       10.18   4.83   1.50   1.52    2.75     8.44   25.43   34.20   44.20
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   GEOMETRIC MEAN & PERCENT FINES BREAK DOWN FOR PINE3A
LLECTED :10/1/92
ERCENT FINES FOR THIS SAMPLE ARE BASED ON GRAIN SIZES <  1.000 mm

AMPLE  Dg1      Dg2     Percent     Percent of Sample retained by given Sieve
 #      mm       mm      Fines      <.125      <1.0      <4.0     <32.0     <100

 1    13.54     7.69    12.56       3.61       8.95     17.37     25.98    44.10
 2     4.93     2.87    26.84       7.35      19.49     16.83     46.35     9.97
 3    11.10     7.09    12.96       2.59      10.38     19.43     36.36    31.24
 4     5.73     3.87    23.87       6.00      17.88     19.44     41.42    15.27

VERAGES FOR ALL  4  SAMPLES:

       8.83     5.38    19.06       4.89      14.17     18.27     37.53    25.15
ESULTS FOR PINE3A                COLLECTED : 10/1/92

          |<----QUALITY INDICES----\|<--DISTRIBUTION DESCRIPTORS----\|
SAMPLE     GEOM.     SORT.     FREDLE    STANDARD     SKEW      KURTOSIS
 #         MEAN      COEF.     INDEX     DEV.
 1         13.54     3.638     3.723     5.4765     -.2401     0.6145
 2          4.93     3.918     1.259     7.3603     -.0083     0.4827
 3         11.10     3.668     3.025     5.4157     0.0082     0.5278
 4          5.73     4.004     1.432     7.8606     0.0337     0.4311

VERAGES     8.83     3.807     2.360     6.528      -.0516     0.5140

INDEX     SAMPLE n      MEAN        STANDARD DEV            95 % CONFID. INTRVL
 DG           4         8.826          4.170               (  2.197 -  15.456)
 SO           4         3.807          0.182               (  3.518 -   4.096)
 FI           4         2.360          1.208               (  0.439 -   4.280)

GS TO EMERGENCE SURVIVAL RATES FOR STEELHEAD, COHO & CHINOOK SALMON BASED ON
5 PERCENT CONFIDENCE INTERVALS for Dg & FI.

          Confidence Interval Ranges             Based on average
            Lower           Higher                  Dg and FI

TEELHEAD     *=16.36 %   to    76.73 %                  53.75 % *

HO           *=39.21 %   to    59.65 %                  33.79 % *

INOOK          1.35 %   to    53.22 %                 16.45 %

* STEELHEAD & COHO SURVIVAL RATES BASED ON FI
  CHINOOK SURVIVAL RATES BASED ON (Dg/Egg diameter) RELATIONSHIP


EOMETRIC MEANS, STAND. DEV.'s, & PERCENTILES FOR PINE3A
OLLECTED :10/1/92
MPL #   Dg1       Sd     D5     D16      D25      D50      D75      D84      D95
------------------------------------------------------------------------------
  1     13.54    5.48   0.21   1.40     2.87    20.37    37.96    42.11    51.78
  2      4.93    7.36   0.10   0.39     0.87     5.01    13.28    21.12    37.86
  3     11.10    5.42   0.28   1.31     2.54    10.94    34.23    38.39    48.27
  4      5.73    7.86   0.11   0.49     1.08     5.35    17.36    30.44    41.63

------------------------------------------------------------------------------
verages for all  4  samples

         8.83    6.53   1.25   0.90     1.84    10.42    25.71    33.01    44.89
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NO 63

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   GEOMETRIC MEAN & PERCENT FINES BREAK DOWN FOR RINE3C
OLLECTED : 10/1/93
 PERCENT FINES FOR THIS SAMPLE ARE BASED ON GRAIN SIZES <  1.000 mm

SAMPLE  Dg1      Dg2     Percent     Percent of Sample retained by given Sieve
  #     mm       mm       Fines      <.125      <1.0      <4.0     <32.0     <100

  1    11.39    5.46     17.65       8.02       9.63      6.60     40.31    35.43
  2    10.06    5.63     17.03      10.22       6.81     15.08     27.03    40.87
  3     9.68    6.81     13.81       8.16       5.65     17.80     38.47    29.92
  4     4.28    2.45     25.17       7.79      17.38     23.42     45.98     5.43

AVERAGES FOR ALL  4  SAMPLES:

        8.85    5.09     18.42       8.55       9.87     15.73     37.95    27.91
RESULTS FOR RINE3C                  COLLECTED : 10/1/93

              |<----QUALITY INDICES----||<--DISTRIBUTION DESCRIPTORS----->|
SAMPLE       GEOM.     SORT.      FREDLE   STANDARD     SKEW      KURTOSIS
  #          MEAN      COEF.      INDEX    DEV.
  1          11.39     2.919      3.900    7.2540     -.1530     0.5727
  2          10.06     4.107      2.450    7.3343     -.2375     0.6037
  3           9.68     3.646      2.654    5.5705     -.0606     0.8075
  4           4.28     3.163      1.355    6.0361     0.0136     0.6133

AVERAGES      8.85     3.459      2.590    6.549      -.1094     0.6493

 INDEX     SAMPLE n       MEAN       STANDARD DEV          95 % CONFID. INTRVL
  DG          4          8.853         3.133              ( 3.872 -  13.834)
  SO          4          3.459         0.528              ( 2.620 -   4.298)
  FI          4          2.590         1.044              ( 0.931 -   4.249)

EGG TO EMERGENCE SURVIVAL RATES FOR STEELHEAD, COHO & CHINOOK SALMON BASED ON
95 PERCENT CONFIDENCE INTERVALS for Dg & FI

           Confidence Interval Ranges            Based on Average
             Lower            Higher               Dg and FI

TEELHEAD     15.48 %    to    76.46 %              57.44 % *

OHO          -6.63 %    to    59.33 %              37.83 % *

HINOOK        3.05 %    to    44.49 %              16.55 %

* STEELHEAD & COHO SURVIVAL RATES BASED ON FI
  CHINOOK SURVIVAL RATES BASED ON (Dg/Egg diameter) RELATIONSHIP


GEOMETRIC MEANS, STAND. DEV.'s, & PERCENTILES FOR RINE3C
OLLECTED : 10/1/93
SMPL n   Dg1      Sg     D5    D16      D25      D50      D75      D84      D95
---------------------------------------------------------------------------------
  1     11.39    7.25   0.10  0.75     4.16    15.42    35.47    39.64    49.45
  2     10.06    7.33   0.09  0.77     2.20    16.16    37.11    41.27    50.99
  3      9.68    5.57   0.10  1.22     2.54    10.74    33.78    37.94    47.84
  4      4.28    6.04   0.10  3.41     0.98     4.18     9.84    14.80    32.60

---------------------------------------------------------------------------------
Averages for all  4  samples

         8.85    6.55   1.25  0.79     2.47    11.62    29.05    33.41    45.22
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    GEOMETRIC MEAN & PERCENT FINES BREAK DOWN FOR PINE3D
COLLECTED :10/1/94
 PERCENT FINES FOR THIS SAMPLE ARE BASED ON GRAIN SIZES <  1.000 mm

 SAMPLE  Dg1      Dg2     Percent     Percent of Sample retained by given Sieve
   #     mm       mm       Fines      <.125      <1.0      <4.0      <32.0    <100

   1     7.97     5.56     12.79       2.46      10.33     23.68     51.94   11.59
   2     3.94     2.51     15.17       2.58      12.59     47.41     37.42    0.00
   3    10.03     6.54     13.75       2.76      10.99     15.22     51.60   19.43
   4    10.97     6.72     14.12       2.71      11.42     16.42     40.36   29.10

AVERAGES FOR ALL  4  SAMPLES:

         8.23     5.33     13.96       2.63      11.33     25.68     45.33   15.03
RESULTS FOR PINE3D                    COLLECTED : 10/1/94

           |<----QUALITY INDICES---->|<--DISTRIBUTION DESCRIPTORS---->|
 SAMPLE     GEOM.     SORT.     FREDLE   STANDARD    SKEW      KURTOSIS
   #        MEAN      COEF      INDEX    DEV
   1         7.97     2.644     3.015    4.3493     0.1535     0.6697
   2         3.94     1.862     2.119    2.4287     0.3486     1.0124
   3        10.03     2.886     3.472    5.1653     0.0641     0.5672
   4        10.97     3.560     3.083    5.6024     0.0067     0.5171

AVERAGES     8.23     2.738     2.922    4.386      0.1432     0.6916

 INDEX    SAMPLE n      MEAN      STANDARD DEV           95 % CONFID. INTRVL
  DG          4         8.228        3.119               ( 3.270 -  13.187)
  SO          4         2.738        0.700               ( 1.625 -   3.851)
  FI          4         2.922        0.573               ( 2.011 -   3.833)

EGG TO EMERGENCE SURVIVAL RATES FOR STEELHEAD, COHO & CHINOOK SALMON BASED ON
95 PERCENT CONFIDENCE INTERVALS for Dg & Fi

          Confidence Interval Ranges           Based on average
             Lower         Higher                Dg and Fi

STEELHEAD    47.33 %   to   72.60 %              62.19 % *

COHO         26.85 %   to   54.85 %              43.07 % *

CHINOOK       2.03 %   to   41.01 %              14.15 %

 * STEELHEAD & COHO SURVIVAL RATES BASED ON Fi
   CHINOOK SURVIVAL RATES BASED ON (Dg/Egg diameter) RELATIONSHIP


GEOMETRIC MEANS, STAND. DEV.'s, & PERCENTILES FOR PINE3D
COLLECTED :10/1/94
SMPL #   Dg1      Sg     D5    D16      D25      D50      D75      D84      D95
--------------------------------------------------------------------------------
   1      7.97   4.35  0.29   1.28     2.25     6.36    15.71    24.17    39.05
   2      3.94   2.63  0.25   1.03     1.44     2.89     5.00     6.10     9.07
   3     10.03   5.17  0.25   1.27     2.92     9.02    24.34    33.80    43.81
   4     10.97   5.60  0.25   1.20     2.65    10.85    33.49    37.66    47.56

---- ---------------------------------------------------------------------------
averages for all  4  samples

          8.23   4.39  1.25   1.19     2.31     7.28    19.64    25.43    34.87
   GEOMETRIC MEAN & PERCENT FINES BREAK DOWN FOR RC12A
OLLECTED :10/14/92
PERCENT FINES FOR THIS SAMPLE ARE BASED ON GRAIN SIZES <  1.000 mm

SAMPLE  Dg1      Dg2     Percent     Percent of Sample retained by given Sieve
  #     mm       mm       Fines      <.125      <1.0       <4.0      <32.0      <100

  1    11.13    8.05      8.52       1.91       6.61      19.58     53.20     18.69
  2     9.60    6.18      8.08       1.54       6.53      20.50     64.51      6.91
  3     8.94    6.80     11.14       3.02       8.12      22.59     50.99     15.28
  4     7.58    5.44     12.85       4.55       8.30      23.44     52.71     10.99

VERAGES FOR ALL  4  SAMPLES:

        9.31    6.62     10.15       2.76       7.39      21.53     55.35     12.97
RESULTS FOR RC12A               COLLECTED : 10/14/92

          |<----QUALITY INDICES---->|<--DISTRIBUTION DESCRIPTORS---->|
SAMPLE     GEOM.     SORT      FREDLE    STANDARD     SKEW      KURTOSIS
  #        MEAN      COEF.     INDEX     DEV.
  1        11.13     2.640     4.216     4.1538      0.1430     0.5962
  2         9.60     2.052     4.678     3.1482      0.2640     0.8190
  3         8.94     2.720     3.286     4.5164      0.1260     0.6666
  4         7.58     2.599     2.915     4.2660      0.1231     0.9046

VERAGES     9.31     2.503     3.774     4.021       0.1640     0.7466

INDEX    SAMPLE n     MEAN      STANDARD DEV          95 % CONFID. INTRVL
  DG         4        9.311       1.475               ( 6.966 -  11.656)
  SO         4        2.503       0.305               ( 2.018 -   2.987)
  FI         4        3.774       0.814               ( 2.479 -   5.068)

EGG TO EMERGENCE SURVIVAL RATES FOR STEELHEAD, COHO & CHINOOK SALMON BASED ON
5 PERCENT CONFIDENCE INTERVALS FOR Dg & FI

          Confidence Interval Ranges          Based on Average
            Lower          Higher               Dg and FI

TEELHEAD    55.12 %   to   82.88 %              72.07 % *

OHO         45.94 %   to   66.98 %              56.18 % *

INOOK        9.29 %   to   31.72 %              18.31 %

* STEELHEAD & COHO SURVIVAL RATES BASED ON FI
  CHINOOK SURVIVAL RATES BASED ON (Dg/Egg diameter) RELATIONSHIP


EOMETRIC MEANS, STAND. DEV, Sg, & PERCENTILES FOR RC12A
OLLECTED :10/14/92
MPL #   Dg1      Sg     D5     D16      D25       D50       D75       D84       D95
------------------------------------------------------------------------------------
  1     11.13   4.15   0.46   1.94     3.39      9.08     23.59     33.42     43.44
  2      9.60   3.15   0.53   1.96     3.34      7.09     14.05     19.46     34.61
  3      8.94   4.52   0.27   1.51     2.62      7.39     19.40     40.73     61.63
  4      7.58   4.27   0.15   1.27     2.26      6.34     15.26     23.30     38.49

------------------------------------------------------------------------------------
verages for all  4  samples

         9.31   4.02   0.35   1.67     2.90      7.47     18.08     26.70     44.54
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7.2

11

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   GEOMETRIC MEAN & PERCENT FINES BREAK DOWN FOR RC12B
OLLECTED :9/15/93
PERCENT FINES FOR THIS SAMPLE ARE BASED ON GRAIN SIZES <  1.000 mm

SAMPLE  Dg1      Dg2     Percent    Percent of Sample retained by given Sieve
  #     mm       mm       Fines     < .125     <1.0      <4.0     <32.0      <100

  1    10.76    7.79      8.62      0.00       8.62     30.41     31.34   29.63
  2    10.67    5.80     18.20      1.54      16.66     14.39     34.63   32.79
  3     7.34    6.16     14.46      2.03      12.42     32.01     31.99   21.55

VERAGES FOR ALL  3  SAMPLES:

        9.59    6.59     13.76      1.19     12.57     25.60     32.65   27.99
ESULTS FOR RC12B                 COLLECTED : 9/15/93

         |<----QUALITY INDICES---->|<--DISTRIBUTION DESCRIPTORS---->|
SAMPLE     GEOM.     SORT.    FREDLE   STANDARD     SKEW     KURTOSIS
  #        MEAN      COEF.    INDEX    DEV
  1        10.76     3.736    2.881    4.8544     0.1785    0.2992
  2        10.67     4.125    2.588    6.6917     -.0330    0.3368
  3         7.34     3.765    1.949    5.6434     0.2291    0.4508

VERAGES     9.59     3.875    2.473    5.730      0.1248    0.3623

INDEX     SAMPLE n      MEAN      STANDARD DEV          95 % CONFID. INTRVL
  DG          3         9.591        1.954              (  4.741 -  14.442)
  SO          3         3.875        0.217              (  3.337 -   4.413)
  FI          3         2.473        0.477              (  1.289 -   3.656)

EGG TO EMERGENCE SURVIVAL RATES FOR STEELHEAD, COHO & CHINOOK SALMON BASED ON
95 PERCENT CONFIDENCE INTERVALS for Dg & FI

          Confidence Interval Ranges          Based on Average
            Lower          Higher               Dg and FI

TEELHEAD     9.04 %   to   70.82 %              55.61 % *

OHO          7.52 %   to   52.40 %              35.82 % *

HINOOK       4.52 %   to   47.76 %              19.39 %

* STEELHEAD & COHO SURVIVAL RATES BASED ON FI
  CHINOOK SURVIVAL RATES BASED ON (Dg/Egg diameter) RELATIONSHIP


EOMETRIC MEANS, STAND. DEV., & PERCENTILES FOR RC12B
OLLECTED :9/15/93
SMPL #   Dg1     Sg     D5    D16     D25      D50      D75      D84     D95
-----------------------------------------------------------------------------
  1     10.76   6.66   0.39   1.61    2.41     8.12    33.68    37.84   47.74
  2     10.67   6.69   0.30   0.87    2.04    11.37    34.66    38.83   48.69
  3      7.34   5.64   0.30   1.09    1.73     4.94    24.50    34.75   44.74

-----------------------------------------------------------------------------
Averages for all  3  samples

         9.59   6.33   0.33   1.19    2.06     8.14    30.95    37.14   47.06
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61

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  GEOMETRIC MEAN & PERCENT FINES BREAK DOWN FOR RC19A
OLLECTED :9/16/92
PERCENT FINES FOR THIS SAMPLE ARE BASED ON GRAIN SIZES <  1.000 mm

SAMPLE  Dg1      Dg2     Percent     Percent of Sample retained by given Sieve
  #     mm       mm       Fines      <.125       <1.0       <4.0      <32.0      <100

  1      7.40     5.65    15.92       5.49       10.43      21.37      46.87    15.84
  2      6.59     4.93    13.80       3.76       10.05      28.68      48.20     9.31
  3     11.79     7.96    10.24       1.38        8.86      19.40      43.77    26.59
  4      5.61     3.87    15.10       4.60       10.50      30.36      50.15     4.39

AVERAGES FOR ALL  4  SAMPLES:

         7.85     5.55    13.77       3.81        9.96      24.95      47.25    14.03
RESULTS FOR RC19A                  COLLECTED : 9/16/92

          |<----QUALITY INDICES---->|<--DISTRIBUTION DESCRIPTORS---->|
SAMPLE      GEOM.      SORT.      FREDLE    STANDARD      SKEW      KURTOSIS
  #         MEAN       COEF       INDEX     DEV
  1          7.40       3.142      2.356     5.6109      0.0674     0.6995
  2          6.59       2.638      2.498     4.2129      0.1466     0.8254
  3         11.79       3.280      3.618     4.6777      0.0796     0.5054
  4          5.61       2.393      2.342     3.6638      0.1611     1.0437

AVERAGES     7.85       2.867      2.704     4.541       0.1184     0.7685

INDEX     SAMPLE n        MEAN      STANDARD DEV            95 % CONFID. INTRVL
 DG           4           7.846       2.733                 (  3.501 -  12.191)
 SO           4           2.867       0.411                 (  2.203 -   3.531)
 FI           4           2.704       0.614                 (  1.729 -   3.679)

ROR TO EMERGENCE SURVIVAL RATES FOR STEELHEAD, COHO & CHINOOK SALMON BASED ON
95 PERCENT CONFIDENCE INTERVALS FOR Dg & Fi

            Confidence Interval Ranges             Based on average
              Lower           Higher                 Dg and Fi

TEELHEAD     47.17 %    TO    51.06 %               48.14 % *

OHO          20.25 %    TO    53.04 %               39.10 % *

HINOOK        2.62 %    TO    35.02 %               12.68 %

* STEELHEAD & COHO SURVIVAL RATES BASED ON FI
  CHINOOK SURVIVAL RATES BASED ON (Dg/Egg diameter) RELATIONSHIP


GEOMETRIC MEANS, STAND. DEV. ., & PERCENTILES FOR RC19A
OLLECTED :9/16/92
SMPL #    Dg1       Sg      D5     D16      D25       D50       D75       D84       D95
-------------------------------------------------------------------------------------
  1        7.40    5.61   0.12   1.01      1.93      6.49     19.08     31.67     41.43
  2        6.59    4.21   0.20   1.15      1.89      5.19     13.09     20.36     37.21
  3       11.79    4.68   0.45   1.48      3.07     10.43     32.61     36.75     46.63
  4        5.61    3.56   0.15   1.06      1.71      4.55      9.82     14.17     29.43

-------------------------------------------------------------------------------------
averages for all  4  samples

           7.85    4.54   1.25   1.22      2.15      6.69     18.65     25.74     38.80
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7.2
4.0

44

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 GEOMETRIC MEAN & PERCENT FINES BREAK DOWN FOR BC19B
LLECTED  8/25/93
PERCENT FINES FOR THIS SAMPLE ARE BASED ON GRAIN SIZES <  1.000 mm

SAMPLE  Dg1     Dg2     Percent    Percent of Sample retained by given Sieve
  #     mm      mm      Fines      <.125      <1.0      <4.0     <32.0     <100

  1      8.99    6.50    13.28      2.35     10.93     22.31     44.55    19.86
  2      9.16    6.92    11.35      2.43      8.93     22.53     49.50    16.61
  3     16.68    9.56     9.05      1.64      7.41     13.65     35.04    42.07
  4     11.15    6.67    14.36      1.58     12.77     17.74     36.84    31.07

VERAGES FOR ALL  4  SAMPLES:

        11.49    7.41    12.01      2.00     10.01     19.10     41.48    27.40
ESULTS FOR BC19B                COLLECTED : 8/25/93

          <-----QUALITY INDICES-----><--DISTRIBUTION DESCRIPTORS----->
SAMPLE     GEOM.      SORT.      FREDLE     STANDARD      SKEW       KURTOSIS
  #        MEAN       COEF.      INDEX      DEV.
  1         8.99      3.250      2.767      5.2377       0.1041      0.5177
  2         9.16      2.816      3.25[illegible]      4.8747       0.12[illegible]      0.5850
  3        16.68      2.861      5.828      4.7431       -.1790      0.5991
  4        11.15      3.738      2.98[illegible]      [illegible]       [illegible]      0.4196

VERAGES    11.49      3.166      [illegible]      4.000        0.0253      0.5303

INDEX     SAMPLE n       MEAN        STANDARD DEV            95 % CONFID. INTRVL
  Dg          4          11.495        3.592                 ( 5.784 -  17.206)
  SC          4           3.166        0.428                 ( 2.485 -   3.848)
  FI          4           3.707        1.428                 ( 1.437 -   5.978)

PROJ. TO EMERGENCE SURVIVAL RATES FOR STEELHEAD, COHO & CHINOOK SALMON BASED ON
 95 PERCENT CONFIDENCE INTERVALS FOR Dg & FI

           Confidence Interval Ranges            Based on average
           Lower            Higher               Dg and FI

TEELHEAD     33.60 %    to    68.89 %            71.35 % *

COHO         17.29 %    to    74.15 %            53.41 % *

CHINOOK       8.28 %    to    61.91 %            30.[illegible] %

* STEELHEAD & COHO SURVIVAL RATES BASED ON FI
  CHINOOK SURVIVAL RATES BASED ON (Dg/Egg Diameter) RELATIONSHIP


GEOMETRIC MEANS, STAND. DEV. s, & PERCENTILES FOR BC19B
COLLECTED  8/25/93
SMPL #   Dg1      Sg     D5     D16      D25       D50       D75       D84       D95
------------------------------------------------------------------------------------
  1      8.99    5.24   0.29   1.24     2.27      7.57     17.97     34.07     44.03
  2      9.16    4.67   0.32   1.49     2.59      7.54     20.57     32.33     42.35
  3     16.68    4.34   0.47   2.20     4.56     20.05     37.37     41.53     51.24
  4     11.15    5.74   0.34   1.16     2.44     10.96     24.17     38.33     48.21

------------------------------------------------------------------------------------
Averages for all  4  samples

        11.49    5.00   1.25   1.52     2.97     11.63     23.02     36.55     46.46
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31

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   GEOMETRIC MEAN & PERCENT FINES BREAK DOWN FOR PC20A
LLECTED :9/15/92
PERCENT FINES FOR THIS SAMPLE ARE BASED ON GRAIN SIZES <  1.000 mm

AMPLE  Dg1      Dg2     Percent    Percent of Sample retained by given Sieve
 #     mm       mm       Fines     <.125      <1.0      <4.0     <32.0     <100

 1     9.55     7.30     10.66      3.36       7.30     24.72     41.78    22.84
 2     5.92     4.68     19.16      7.37      11.79     27.74     33.02    20.09
 3     4.22     1.97     25.21     15.95       9.26     21.69     37.62    15.49
 4     5.19     3.83     21.71      9.62      12.09     27.91     29.46    20.91

ERAGES FOR ALL  4  SAMPLES:

       6.22     4.45     19.18      9.07      10.11     25.51     35.47    19.83
SULTS FOR PC20A                  COLLECTED : 9/15/92

         |<----QUALITY INDICES---->|<--DISTRIBUTION DESCRIPTORS---->|
AMPLE    GEOM.     SORT.     FREDLE   STANDARD     SKEW       KURTOSIS
 #       MEAN      COEF      INDEX    DEV.
 1        9.55     3.377     2.827     4.8462     0.1047     0.6394
 2        5.92     3.965     1.493     7.2966     0.1065     0.5280
 3        4.22     4.181     1.009    15.6009     -.0354     0.1667
 4        5.19     4.325     1.200     8.9885     0.1082     0.4172

ERAGES    6.22     3.962     1.632     9.183      0.0710     0.4378

NDEX     SAMPLE n      MEAN       STANDARD DEV          95 % CONFID. INTRVL
 DG         4          6.219        2.326              ( 2.522 -   9.915)
 SO         4          3.962        0.417              ( 3.299 -   4.625)
 FI         4          1.632        0.821              ( 0.327 -   2.937)

ED % EMERGENCE SURVIVAL RATES FOR STEELHEAD, COHO & CHINOOK SALMON BASED ON
 PERCENT CONFIDENCE INTERVALS FOR Dg & FI

         Confidence Interval Ranges           Based on Average
           Lower          Higher                Dg and FI

ELHEAD      <-29.02 %  to   62.39 %               38.83 % *

O           <-52.03 %  to   43.29 %               17.78 % *

NOOK          1.55 %   to   21.01 %               7.02 %

STEELHEAD & COHO SURVIVAL RATES BASED ON FI
CHINOOK SURVIVAL RATES BASED ON (Dg/Egg diameter) RELATIONSHIP


OMETRIC MEANS, STAND. DEV.'s, & PERCENTILES FOR PC20A
LLECTED :9/15/92
G. #    Dg1     Sg     D5    D16     D25     D50     D75     D84     D95
--------------------------------------------------------------------------
 1      9.55   4.85   0.26   1.51    2.60    9.00   28.52   35.30   46.37
 2      5.92   7.30   0.10   0.64    1.41    4.70   22.19   34.13   44.12
 3      4.22  15.60   0.07   0.14    0.86    4.65   16.73   30.79   41.75
 4      5.19   8.99   0.09   0.43    1.21    4.09   22.63   34.44   43.44

--------------------------------------------------------------------------
erages for all  4  samples

        6.22   9.18   1.25   0.68    1.52    5.61   22.52   33.69   43.92
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5°
7°

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   GEOMETRIC MEAN & PERCENT FINES BREAK DOWN FOR BC20B
OLLECTED :8/5/93
PERCENT FINES FOR THIS SAMPLE ARE BASED ON GRAIN SIZES <  1.000 mm

SAMPLE  Dg1       Dg2     Percent     Percent of Sample retained by given Sieve
  #     mm        mm       Fines      <.125     <1.0      <4.0      <32.0     <100

  1      10.37     6.78    13.38       2.13     11.25     18.77     42.45    25.39
  2      11.33     7.14    13.07       3.20      9.87     14.95     44.65    27.33
  3       7.70     5.82    12.84       1.62     11.22     27.57     46.04    13.56
  4      14.06     9.08     9.25       1.62      7.64     13.43     48.53    28.79

VERAGES FOR ALL  4  SAMPLES:

         10.86     7.21    12.14       2.14     10.00     18.68     45.42    23.77
ESULTS FOR BC20B                  COLLECTED : 8/5/93

          <-----QUALITY INDICES----><--DISTRIBUTION DESCRIPTORS----->
SAMPLE     GEOM.     SORT.     FREDLE    STANDARD     SKEW      KURTOSIS
  n        MEAN      COEF.     INDEX     DEV.
  1        10.37     3.469     2.905     5.3586     0.0591     0.4986
  2        11.33     3.332     3.504     5.1846     0.0116     0.6114
  3         7.70     2.854     2.700     4.7022     0.1820     0.5283
  4        14.06     2.737     5.137     4.1337     0.0496     0.6334

VERAGES    10.86     3.098     3.562     4.845      0.0756     0.5679

INDEX     SAMPLE n      MEAN      STANDARD DEV            95 % CONFID. INTRVL
 DG          4         10.865        2.622               (  6.694 -  15.035)
 SO          4          3.098        0.379               (  2.495 -   3.700)
 FI          4          3.562        1.104               (  1.806 -   5.317)

ESS TO ESTIMATE SURVIVAL RATES FOR STEELHEAD, COHO & CHINOOK SALMON BASED ON
5 PERCENT CONFIDENCE INTERVALS FOR DG & FI

           Confidence Interval Ranges            Based on Average
              Lower           Higher               Dg and FI

TEELHEAD    [illegible] %  TO  [illegible] %          48.82 % *

OHO           22.18 %   TO   [illegible] %          51.66 % *

HINOOK         8.25 %   TO   50.96 %               26.86 %

* STEELHEAD & COHO SURVIVAL RATES BASED ON FI
  CHINOOK SURVIVAL RATES BASED ON (Dg/Egg diameter) RELATIONSHIP


GEOMETRIC MEANS, STAND. DEV.'s, & PERCENTILES FOR BC20B
OLLECTED :8/5/93
SAMPLE #   Dg1     Sg    D5     D16      D25      D50      D75      D84      D95
-------------------------------------------------------------------------------
  1       10.37   5.76  0.30   1.26     2.62     9.39    32.16    36.31    46.27
  2       11.33   5.18  0.23   1.38     3.15    11.11    32.88    37.04    46.97
  3        7.70   4.70  0.36   1.24     2.04     5.81    16.59    27.36    40.62
  4       14.06   4.13  0.46   2.20     4.45    13.10    33.39    37.55    47.46

-------------------------------------------------------------------------------
verages for all  4  samples

          10.86   4.94  1.25   1.52     3.06     9.85    28.75    34.56    45.33
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C2
37

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  GEOMETRIC MEAN & PERCENT FINES BREAK DOWN FOR RC21A
LLECTED : 10/19/92
ERCENT FINES FOR THIS SAMPLE ARE BASED ON GRAIN SIZES <  1.000 mm

AMPLE  Dg1     Dg2     Percent    Percent of Sample retained by given Sieve
 #     mm      mm       Fines     <.125      <1.0      <4.0     <32.0    <100

 1     8.13    6.47    14.29      6.71       7.58     26.50     30.62    28.59
 2     7.75    6.57    12.79      6.63       6.15     26.78     39.27    21.16
 3     8.23    7.23     7.89      2.77       5.12     33.40     42.41    16.29
 4    11.09    8.23     7.80      3.16       4.65     25.03     40.29    26.88

VERAGES FOR ALL  4  SAMPLES:

       8.80    7.13    10.69      4.82       5.88     27.93     38.15    23.23
SULTS FOR RC21A                  COLLECTED : 10/19/92

        <-----QUALITY INDICES-----><---DISTRIBUTION DESCRIPTORS---->
SAMPLE    GEOM.     SORT.     FREDLE    STANDARD     SKEW      KURTOSIS
  #       MEAN      COEF.     INDEX     DEV.
  1        8.13     4.179     1.946     5.7882      0.0631     0.7353
  2        7.75     3.461     2.239     5.2597      0.0891     0.8147
  3        8.23     2.817     2.922     4.4465      0.2328     0.5574
  4       11.09     3.361     3.299     4.4822      0.0962     0.6172

VERAGES    8.80     3.455     2.602     4.994       0.1203     0.6812

INDEX     SAMPLE n      MEAN       STANDARD DEV           95 % CONFID. INTRVL
 DG          4          8.802        1.538               (  6.356 -  11.248)
 SO          4          3.455        0.560               (  2.565 -   4.345)
 FI          4          2.602        0.619               (  1.617 -   3.587)

S TO EMERGENCE SURVIVAL RATES FOR STEELHEAD, COHO & CHINOOK SALMON BASED ON
 PERCENT CONFIDENCE INTERVALS FOR Dg & Fi

          Confidence Interval Ranges              Based on Average
            Lower          Higher                   Dg and Fi

TEELHEAD    [illegible] %   TO   [illegible] %         [illegible] % *

OHO         [illegible] %   TO   [illegible] %         [illegible] % *

HINOOK      [illegible] %   TO   [illegible] %         [illegible] %

 STEELHEAD & COHO SURVIVAL RATES BASED ON Fi
 CHINOOK SURVIVAL RATES BASED ON (Dg/Egg diameter) RELATIONSHIP


OMETRIC MEANS, STAND. DEV. & PERCENTILES FOR RC21A
LLECTED : 10/19/92
PL #    Dg1     Sg      D5     D16     D25      D50      D75      D84      D95
--------------------------------------------------------------------------------
  1     8.13  [illeg] [illeg] [illeg] [illeg]  [illeg] [illeg]  [illeg]  [illeg]
  2     7.75  [illeg]  0.11  [illeg]  [illeg]   6.69    24.94    34.55   [illeg]
  3     8.23   4.45    0.40   1.63   [illeg]  [illeg] [illeg]    42.16    42.18
  4    11.09   4.48    0.37   1.44    2.90     9.60    32.72    36.87   [illeg]

--------------------------------------------------------------------------------
verages for all  4  samples

        8.80   4.99    1.25   1.46    2.33   [illeg]   27.42    35.27   [illeg]
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  GEOMETRIC MEAN & PERCENT FINES FREDLE INDEX FOR RC219
LLECTED : 10/28/93
RCENT FINES FOR THIS SAMPLE ARE BASED ON GRAIN SIZES < 1.000 mm

AMPLE  Dg1     Dg2     Percent    Percent of Sample retained by given Sieve
 #     mm      mm      Fines      <.125     <1.0     <4.0    <32.0     <100

 1     11.21   7.81     9.80      2.06      7.74    23.63    37.52    29.05
 2      6.49   4.32    14.46      6.55      7.91    22.59    57.49     5.46
 3      8.87   6.54    12.26      2.41      9.85    21.90    50.21    15.62
 4     12.95   8.69     9.33      2.42      6.91    14.95    49.39    26.33

ERAGES FOR ALL  4  SAMPLES:

        9.88   6.84    11.46      3.36      8.10    20.77    48.65    19.12
SULTS FOR RC219                COLLECTED : 10/28/93

         <-----QUALITY INDICES-----><---DISTRIBUTION DESCRIPTORS----->
AMPLE     GEOM.     SORT.     FREDLE   STANDARD     SKEW      KURTOSIS
 #        MEAN      COEF.     INDEX    DEV.
 1        11.21     3.508     3.196    4.8413       0.0711    0.5407
 2         6.49     [illegible].398     2.717    3.4520       0.0994    1.1158
 3         8.87     1.810     3.158    4.7840       0.1207    0.5761
 4        12.95     2.807     4.613    4.2188       0.0694    0.6778

VERAGES    9.88     2.879     3.420    4.419        0.0877    0.7260

NDEX    SAMPLE n     MEAN       STANDARD DEV        95 % CONFID. INTERVAL
 DG        4         9.880      2.830               ( 5.413 - 14.347)
 SC        4         2.879      1.084               ( 1.141 -  4.617)
 F         4         3.420      0.824               ( 2.110 -  4.730)

[illegible]   EMERGENCE & SURVIVAL RATES FOR STEELHEAD, COHO & CHINOOK SALMON BASED ON
 PERCENT CONFIDENCE INTERVALS FOR Dg & F.

          [illegible] range  interval Survival        Based on Means
          Lower            Higher                     Dg and F

EELHEAD   49.17 %   TO   80.79 %                      66.[illegible] %

O         24.94 %   TO   43.88 %                      36.41 %

INOOK      4.66 %   TO   47.2[illegible] %                      20.80 %

 STEELHEAD & COHO SURVIVAL RATES BASED ON F.
 CHINOOK SURVIVAL RATES BASED ON Dg/Egg diameter RELATIONSHIP


EOMETRIC MEANS, STAND. DEV. & % PERCENTILES FOR RC219
OLLECTED : 10/28/93
MPL #    Dg1     Sg     D5     D16     D25     D50     D75     D84     D95
------------------------------------------------------------------------------
  1      11.21   4.82   0.38   1.82    2.72   10.37   2[illegible]   47.84   47.[illegible]
  2       6.49   3.85   0.11   1.12    2.08    5.88   1[illegible].76   18.65   32.64
  3       8.87   3.78   0.30   1.37    2.68    7.44   18.41   31.31   41.82
  4      12.95   4.22   0.37   2.06    4.13   11.89   22.42   36.84   46.62

------------------------------------------------------------------------------
VERAGES FOR ALL 4 SAMPLES

          9.88   4.42   0.2[illegible]   1.5[illegible]    2.85    8.42   18.[illegible]   40.5[illegible]   42.1[illegible]
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    GEOMETRIC MEAN & PERCENT FINES BREAK DOWN FOR LPINEA
COLLECTED :10/1/92
 PERCENT FINES FOR THIS SAMPLE ARE BASED ON GRAIN SIZES <  1.000 mm

 SAMPLE  Dg1      Dg2     Percent     Percent of Sample retained by given Sieve
   #     mm       mm       Fines      <.125      <1.0      <4.0      <32.0     <100

   1    11.47     7.69     11.42       2.46      8.96     15.45     49.70    23.43
   2     7.28     2.83     20.46      14.42      6.04     11.54     41.23    26.77
   3     9.02     6.75     12.52       4.89      7.64     20.07     48.42    18.99
   4     6.55     4.92     16.21       5.65     10.56     24.59     46.90    12.30

AVERAGES FOR ALL  4  SAMPLES:

         8.58     5.55     15.15       6.85      8.30     17.91     46.56    20.37
RESULTS FOR LPINEA                  COLLECTED : 10/1/92

           |<----QUALITY INDICES---->|<--DISTRIBUTION DESCRIPTORS---->|
 SAMPLE      GEOM.      SORT.     FREDLE    STANDARD     SKEW      KURTOSIS
   #         MEAN       COEF.     INDEX     DEV.
   1         11.47      2.928     3.919     4.6298      0.0614     0.6226
   2          7.28      4.284     1.699    13.0013      -.1142     0.2631
   3          9.02      3.009     2.998     4.9711      0.0666     0.8077
   4          6.55      2.951     2.219     5.0653      0.0934     0.7941

AVERAGES      8.58      3.293     2.709     6.917       0.0268     0.6219

 INDEX     SAMPLE n      MEAN        STANDARD DEV           95 % CONFID. INTRVL
  DG           4          8.579          2.190              ( 5.097 -  12.062)
  SO           4          3.293          0.662              ( 2.241 -   4.345)
  FI           4          2.709          0.968              ( 1.170 -   4.247)

EGG TO EMERGENCE SURVIVAL RATES FOR STEELHEAD, COHO & CHINOOK SALMON BASED ON
95 PERCENT CONFIDENCE INTERVALS for Dg & FI.

          Confidence Interval Ranges             Based on Average
            Lower            Higher                  Dg and FI

STEELHEAD     25.07 %   to   76.44 %                 59.21 % *

COHO           3.33 %   to   59.31 %                 39.77 % *

CHINOOK        5.13 %   to   34.23 %                 15.50 %

 * STEELHEAD & COHO SURVIVAL RATES BASED ON FI
   CHINOOK SURVIVAL RATES BASED ON (Dg/Egg diameter) RELATIONSHIP


GEOMETRIC MEANS, STAND. DEV.'s, & PERCENTILES FOR LPINEA
COLLECTED :10/1/92
SMPL #    Dg1      Sd      D5     D16      D25       D50       D75       D84      D95
-------------------------------------------------------------------------------------
   1     11.47    4.63   0.32    1.66     3.49     10.44     29.90     35.62    45.59
   2      7.28   13.00   0.07    0.22     1.78      9.75     32.68     36.84    46.77
   3      9.02    4.97   0.13    1.36     2.57      8.11     23.28     33.57    43.59
   4      6.55    5.07   0.12    0.97     1.77      5.63     15.42     24.94    39.67

-------------------------------------------------------------------------------------
Averages for all  4  samples

          8.58    6.92   1.25    1.05     2.40      8.48     25.32     32.74    43.91
```

END

05-30-02